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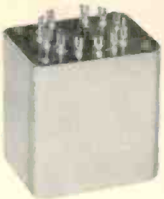
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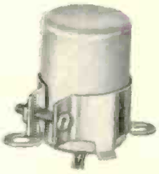
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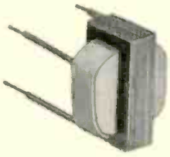
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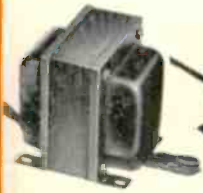
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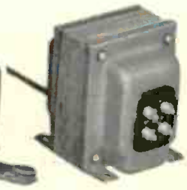
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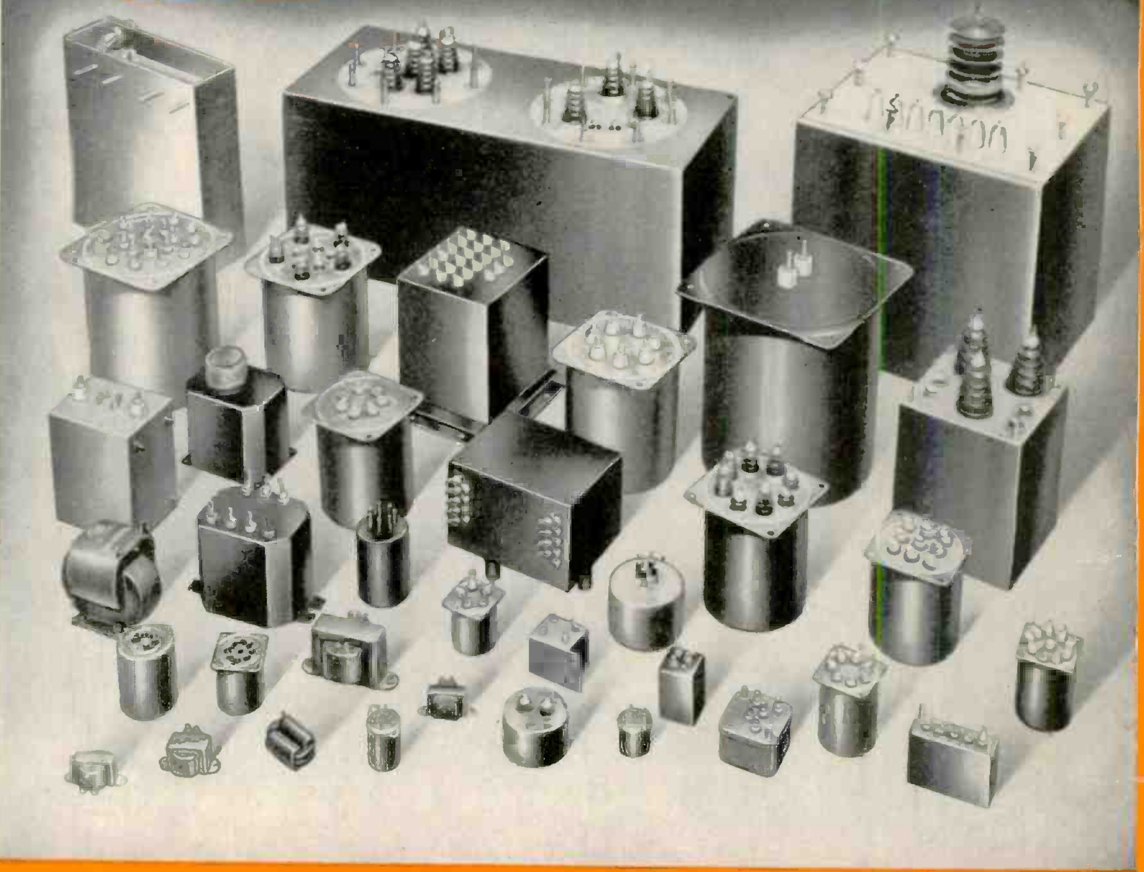

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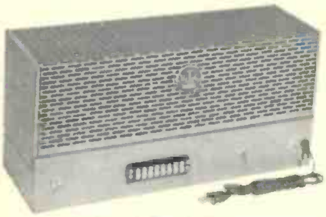
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PUBLICATION

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JULY, 1954

ELECTRONICS
Member ABC and ABP

Vol. 27, No. 7

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electronic frequency changers

250VA and 1000VA capacity
60 ~ to 60 ~ or 60 ~ to 400 ~
accuracy to ±0.01%

- **accurate control of frequency**
- **accurate control of voltage**
- **good wave shape**
- **portable**
- **no special wiring or installation**

SPECIFICATIONS

Model	FCD250	FCD1000	FC1000
Input voltage	95-130VAC, 1Ø, 50-60~	208 or 230VAC, 1Ø, 50-60~	208 or 230VAC 1Ø, 50-60~
Output voltage	115VAC, 1Ø, adjustable between 110-120 volts		
Output Frequency	400 ~, adjustable ±10%	400 ~, adjustable ±10%	60 ~, adjustable between 45 and 65
Output voltage regulation	±1.0%	±1.0%	±1.0%
Output frequency regulation	±1.0% in standard models; ±0.01% with auxiliary frequency standard (output frequency is fixed when using frequency standard)		
Capacity	250VA	1000VA	1000VA
Load range	0.1 to full load		
Distortion	5% maximum		
P. F. range	Down to 0.7 F		
Time constant	0.25 seconds		
Envelope modulation	2% maximum		

These industrial and laboratory frequency changers resulted from contracts for precision inverters. They should prove useful for testing components or complete instruments that must operate over variable frequency conditions. They can also be used as sources for precision 60 ~ or 400 ~ for timing applications, or used with servo and/or gyro motors in design work.

Sorensen electronic frequency changers are also being used with field equipment such as geophysical vans, where motor generator set frequency control is often inadequate. Another use will be for checking equipment designed for 50 ~ (foreign) usage; conversely, the same instrument can be used to convert 50 ~ line to 60 ~ source.

Electronic frequency changers of other ratings are now in design. We shall be happy to send further information, or to correspond with you concerning your individual requirements. Address Sorensen & Co., Inc., 375 Fairfield Avenue, Stamford, Conn. In Europe, write directly to Sorensen A.G., Gartenstrasse 26, Zurich 2, Switzerland.

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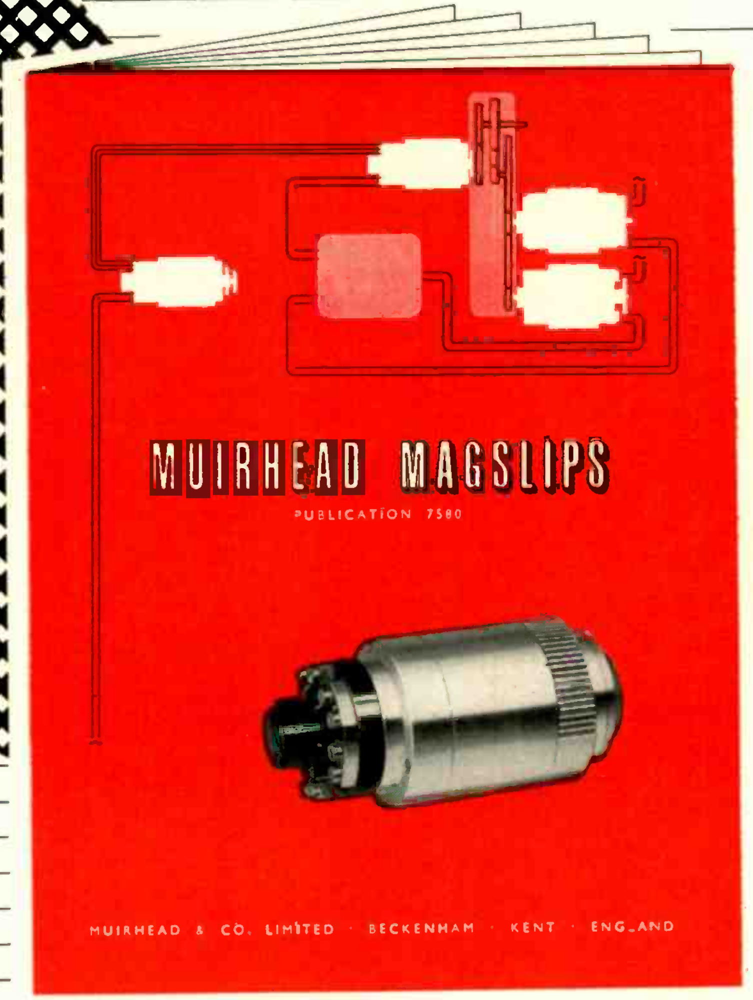
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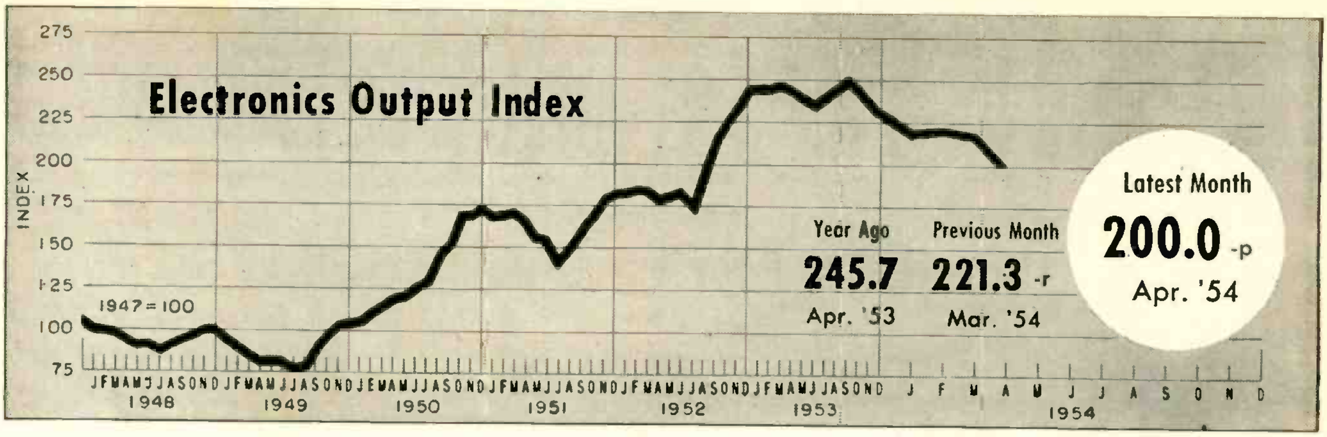


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Year Ago Apr. '53	Previous Month Mar. '54	Latest Month Apr. '54
Television sets, total	567,878	599,606	457,608
With UHF	......	124,855	112,833
Radio sets, total	1,158,936	940,352	745,235
With FM	40,178	19,693	14,008
Home sets	286,974	244,110	165,232
Clock Radios	187,394	119,863	73,590
Portable sets	201,476	206,130	175,424
Auto sets	483,092	370,249	330,989

RECEIVER SALES

(Source: RETMA)	Apr. '53	Mar. '54	Apr. '54
Television sets, units	319,721	512,861	371,720
Radio sets (except auto)	412,802	486,034	427,911

RECEIVING TUBE SALES

(Source: RETMA)	Apr. '53	Mar. '54	Apr. '54
Receiv. tubes, total units	41,342,599	29,063,484	29,640,942
Receiv. tubes, value	$27,720,635	$22,130,627	$21,697,489
Pic. tubes, total units	907,076	759,468	727,655
Picture tubes, value	$21,657,266	$15,904,687	$14,994,779

SEMICONDUCTOR SALES

(Source: RETMA)	Apr. '53	Mar. '54	Apr. '54
Germanium Diodes Silicon Diodes	2,450,015	1,061,010	994,280

INDUSTRIAL TUBE SALES

(Source: NEMA)	Quarterly Figures Year Ago 1st '53	Previous Quarter 4th '53	Latest Quarter 1st '54
Vacuum (non-receiving)	$10,400,000	$9,467,331	$8,971,335
Gas or vapor	$3,300,000	$4,854,222	$4,589,239
Phototubes	$700,000	$405,000	$405,000*
Magnetrons and velocity modulation tubes	$10,500,000	$13,073,095	$16,135,274
Gaps and T/R boxes	$1,700,000	$1,707,730	$1,517,426

*4th quarter 1953

TV AUDIENCE

(Source: NBC Research Dept.)	Year Ago Apr. '53	Previous Month Mar. '54	Latest Month Apr. '54
TV Homes, total	23,256,000	......	29,495,000

BROADCAST STATIONS

Source: (FCC)	May '53	Apr. '54	May '54
TV Stations on Air	189	387	397
TV Stns CPs—not on air	266	190	176
TV Stns—Applications	611	52	45
AM Stations on Air	2,445	2,563	2,575
AM Stns CPs—not on air	130	112	111
AM Stns—Applications	244	158	158
FM Stations on Air	591	552	549
FM Stns CPs—not on air	20	16	18
FM Stns—Applications	9	4	5

COMMUNICATION AUTHORIZATIONS

Source: (FCC)	Apr. '53	Mar. '54	Apr. '54
Aeronautical	38,887	43,324	42,998
Marine	39,745	44,598	45,132
Police, fire, etc.	12,956	15,065	15,241
Industrial	16,515	20,599	21,029
Land Transportation	5,769	6,758	6,829
Amateur	110,884	118,750	120,581
Citizens Radio	2,074	5,612	5,664
Disaster	189	259	271
Experimental	432	544	550
Common carrier	1,144	1,534	1,549

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Mar. '53	Feb. '54	Mar. '54
Prod. workers, comm. equip.	418,300	364,400-r	362,300
Av. wkly. earnings, comm.	$66.67	$67.89-r	$67.55
Av. wkly. earnings, radio	$64.24	$67.09-r	$66.76
Av. wkly. hours, comm.	40.9	39.7 -r	39.5
Av. wkly. hours, radio	40.4	39.7 -r	39.5

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	May '53	Apr. '54	May '54
Radio—TV & Electronics	295.3	304.0	305.3
Radio Broadcasters	287.3	309.5	322.1

p—provisional; r—revised

FIGURES OF THE YEAR

		TOTALS FOR FIRST FOUR MONTHS		
	1953 Total	1953	1954	Percent Change
Television set production	7,214,787	2,827,821	1,904,718	—32.6
Radio set production	13,368,556	4,993,720	3,326,800	—33.4
Television set sales	6,375,279	2,100,620	2,152,515	+ 2.5
Radio set sales (except auto)	7,064,485	1,851,673	1,487,247	—19.7
Receiving tube sales	437,091,555	163,401,335	106,026,920	—35.1
Cathode-ray tube sales	7,582,835	3,705,997	2,690,519	—27.4

INDUSTRY REPORT

electronics—July • 1954

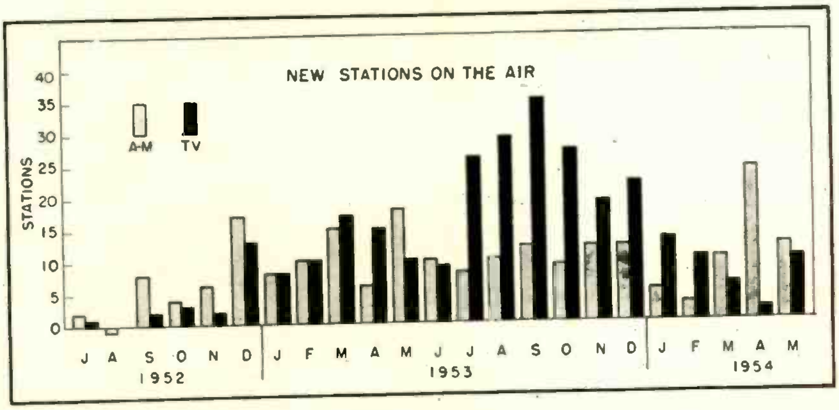
Government Market Is Bigger Than It Seems

FINDING OUT who buys what and where in the federal government has buffaloed a good number of electronic manufacturers who want to sell to the U. S. government. A step toward eliminating this problem has been made by the Small Business Administration which recently published a U. S. Government Purchasing Directory. It lists in detail the supplies and services bought by the military and civilian departments of the federal government, the addresses of their purchasing offices and the necessary procedures for selling them.

▶ **Markets**—The government uses nearly every type of electronic equipment and all types of departments and bureaus buy electronic equipment. For example, there are six military and four different government civilian offices that buy home-type tv receivers. They range from the U. S. Weather Bureau to Army and Air Force post exchanges. There are 16 civilian offices that purchase resistors, ranging from the Bureau of Census to the Bureau of Land Management, and 10 military offices.

▶ **Navy**—Just how big a customer a government department may be is indicated by the operations of just one Navy department, the Electronic Supply Office.

It controls an inventory of 216,000 different line items with a total value of $350 million. During fiscal year 1953, ESO spent $21 million dollars for maintenance repair parts, including tubes. The principal portion of these were from northern Illinois and southeast Wisconsin.



TELEVISION starters decline; new a-m stations increase, as . . .

Business Booms in A-M Radio

Station building climbs as oldtimers revamp studio and transmitting equipment

DON'T sell a-m short—a maxim heard even during the post-freeze boom in television station building, points the way to increasing profits in the broadcast equipment business this year.

▶ **New Stations**—As the chart indicates, a-m radio was good from the transmitting equipment point of view even during the big tv boom in late 1953. Now, with that boom apparently tapering off, the a-m market is climbing even higher. In the past 10 months, 114 new a-m authorizations were issued.

▶ **New Equipment**—Remote control of a-m transmitters, recently authorized by the FCC, accounts for much business. Manufacturers report that 300 packaged units have been sold. Many new a-m transmitters have built-in provision for remote operation.

Next feature for transmitters may be remote control of directional antennas. This is being done now in Canada but is not yet authorized by the FCC for U. S. broadcasters. Remote control manufacturers are working up packages with d-a provisions.

A paper presented to the NARTB convention in Chicago described tape sequencing equipment installed by a Honolulu radio station. Such gear may take over some of the functions of the announcer-disk jockey as well as those of the engineer.

▶ **Replacement**—The market for equipment to replace outmoded gear is one that equipment salesmen are aggressively exploring. Many broadcasters are using transmitters 12 to 15 years old and older. In many cases, parts are not easily obtained. Older rigs often use tubes much less efficient than those developed in recent years. Thus, replacement may prove cheaper than repair. One manufacturer reports three orders for 50-kw plants.

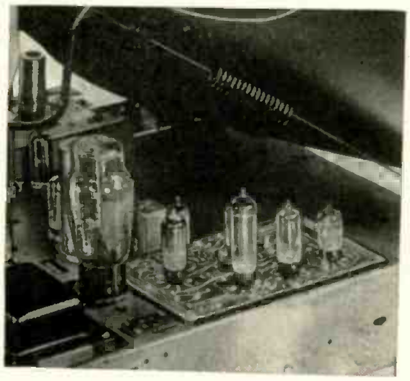
The studio equipment market is also good. Broadcasters are finding a second or third console, additional remote pickup equipment or auxiliary tape-handling gear essential to their operations.

Scientific Apparatus Business Increases

GROWING output of scientific instruments and laboratory apparatus, much of which is electronic, is seen in the large increase in employment in the field. According to the Bureau of Labor Statistics, employees in the laboratory, scientific and engineering instrument field increased from 39,000 in 1951 to 49,000 in 1952 and reached a total of 54,000 in 1953.

▶ **Breakdown**—Indication of how important the various products are saleswise in total scientific instrument sales is indicated by the following figures: In 1953 total sales in the field reached $212.3 million. Of this total $131.9 million was accounted for by laboratory apparatus, $13.3 million by optical and $67.1 million by industrial instruments. Significantly, during 1953, the largest percentage sales increase over the previous year's sales was registered by industrial instruments with a 8.6-percent increase in shipments.

Printed Circuit Bows in TV Line



This section of a 21-inch Admiral tv set uses 4½ by 7-inch printed circuit which incorporates six tubes and one-third of normally-exposed wiring. After components are assembled to the photo-etched copper plate it is dipped in a solder pot at 500 degrees F for three to five seconds

INVENTORS Reynolds and Leies watch their solar generator, at right, enclosed in a plastic shield while . . .

Sunkissed Crystal Turns Motor

LATEST SOLAR power plant, developed at Wright Air Development Center, Dayton, Ohio, uses a yellow cadmium sulfide crystal to change sunlight into electricity. The experimental model uses a crystal about the size of a lump of sugar. Later developments are expected to pare the crystal wafer-thin.

▶ **Getting the Juice**—Attached to opposite sides of the slab are electrodes to which wires connect. A silver electrode is the positive terminal; the negative terminal is indium. The whole unit is known as a barrier-layer cell. Light, striking the crystal-electrode interface, produces a direct-current electrical potential.

▶ **How Much Power**—In the pilot model, a one-eighth square inch area produces a third of a volt. Later models are expected to increase the voltage six to eight times. Doubling or tripling the area will increase power by the same factor. According to the inventors a wafer-thin slab of crystal four by fifteen feet built into the roof of a house will supply enough current to operate all lights, stove, refrigerator and other appliances 24 hours a day.

Electronics Covers The Weather

Radar is being used more extensively and computers may soon enter the picture

U. S. WEATHER BUREAU has 22 radar units in operation in the country and present plans call for use of additional installations for approximately 15 more locations within the next 12 months.

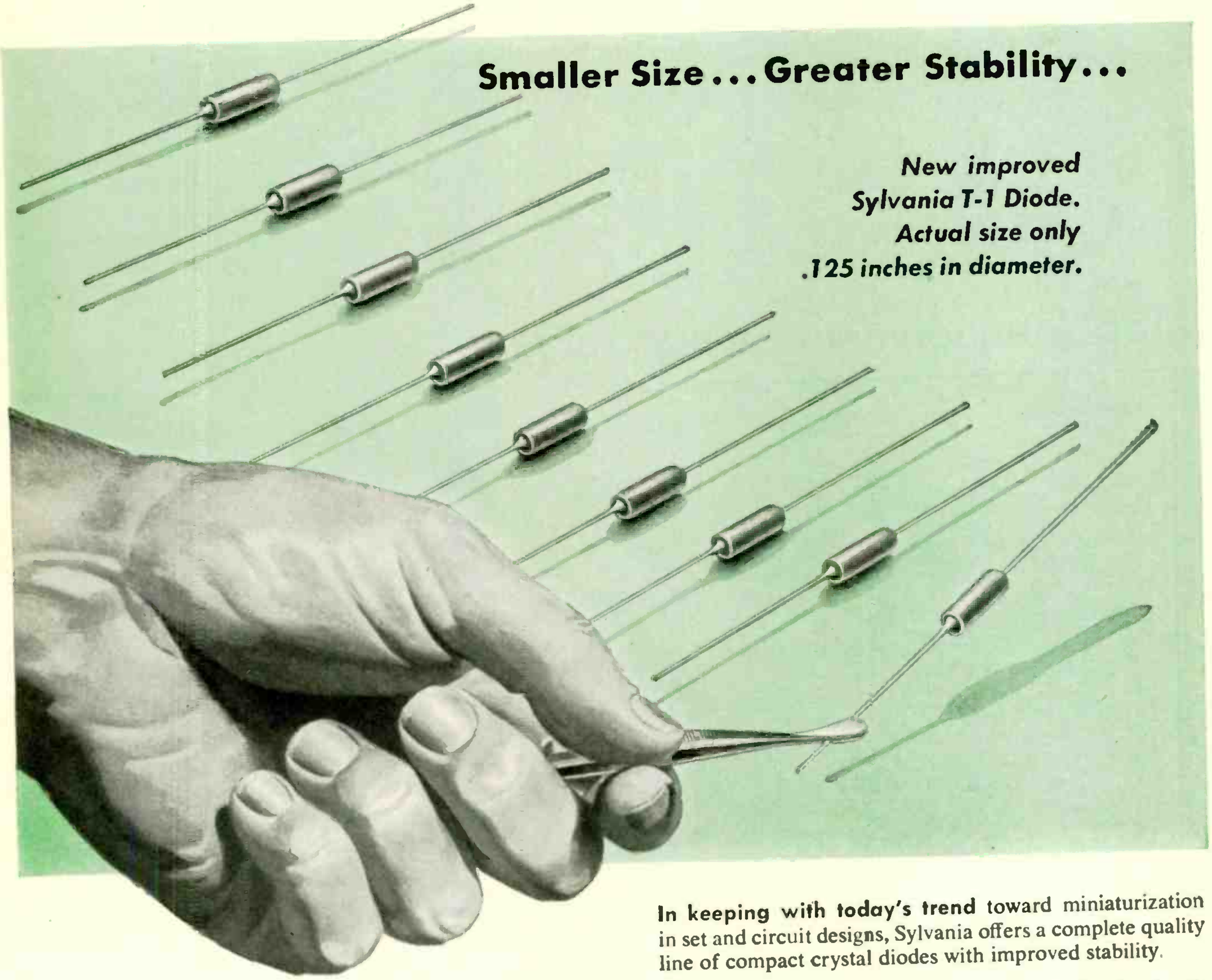
▶ **Network**—Largest number of units in operation at present are in Texas where a tornado picket line of radars is being set up to give an almost complete picture of weather in the state. By the first of July, about 14 radar stations in as many cities across Texas and extending into Louisiana will be in operation. Cities in Oklahoma and in Louisiana may join the network.

Most of the stations in Texas have been set up on a cooperative basis between the individual cities involved and the U. S. Weather

(Continued on page 8)

Sylvania Offers You . . .

A NEW COMPACT DIODE LINE



Smaller Size . . . Greater Stability . . .

New improved Sylvania T-1 Diode. Actual size only .125 inches in diameter.

In keeping with today's trend toward miniaturization in set and circuit designs, Sylvania offers a complete quality line of compact crystal diodes with improved stability.

These new components measure only .125 inches in diameter . . . require only 1/6th the space of former units. At the same time, due to advanced manufacturing techniques and Sylvania's new automatic precision equipment, they provide far higher performance records.

With these tiny diodes, you can be assured of more uniform characteristics and closer tolerance limits . . . even on large quantity orders.

This new T-1 Series also has recently passed MIL-E-1B moisture-resistance tests. Now available in capacities for every need. For full details write to Dept. 4E-1607, Sylvania today!

Another reason why it pays to specify Sylvania!

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Bureau. The Bureau supplies the gear, maintains it and supervises the network. The cities pay about $10,000 to have the gear modified and installed.

▶ **Equipment**—Models used for the tornado belt warning system are mainly APS 2 surplus radars that were turned over to the Weather Bureau by the Navy. An APS 13 is in use in New York City. The surplus gear is converted for weather use and equipped with six-foot antenna dishes. With latest modifications a range of 200 miles is possible. The Bureau has a staff of 35 electronic technicians who service the gear.

Successful use of radar in weather work has prompted some electronic manufacturers to size up the field as a possible market for specially designed sets. One company is already designing radars specifically for locating storm centers.

▶ **Brains**—Electronic computers may also see service in U. S. weather operations. It is reported that the U. S. Weather Bureau, the Air Force and the Navy will start operating an electronic computer for weather predictions on a trial basis beginning in July.

This has been done for some time in Sweden with BESC, Binary Electronic Sequence Computer. Use of the instrument is planned for this summer to make 48-hour weather forecasts on a routine basis. In operating BESC, wind information, for example, is fed into the computer which figures, by prescribed formulas, the winds for each of 48 consecutive hours into the future.

It takes about 10 hours to gather and feed the information into the computer for a 24-hour forecast. The computer, however, does the necessary 2.7 million calculations in less than 30 minutes.

Top Management Salary Survey

Company	Capacity	Salary	Bonus	Pension	Total 1953	Total 1952
Bendix	Pres	$84,233	$39,500	$7,844	$131,577	$177,441
	V-P	60,400	29.250		89,650	91,500
CBS	Pres	235,780		12,335	248.115	165,855
	Chm	100,000		16,526	116,526	118,524
	Dir	240,627			240,627	211,126
DuMont	Pres	103,675			103,675	98,664
	V-P					25,192
Total payments to all officers and directors					184,791	160,397
Emerson	Pres	60,008	25,000	12,054	97,062	72,523
	Treas. & Secy	39,936	20,000	5,934	65,870	46,177
	Ex. V-P	31,980	15,000	3,298	50,278	50,524
Total payments to all officers and directors					427,991	376,964
GE	Pres	214,991			214,991	202,524
	Chm	147,519			147,519	140,028
	Ex. V-P	125,017			125,017	
Magnavox	Total payments to all officers and directors				359,135	290,305
Motorola	Pres	82,500			82,500	82,500
	Ex. V-P	55,000			55,000	55,000
	V-P, Dir. Eng.	55,000			55,000	55,000
Total payments to all officers and directors					648,133	533.132
Olympic	Pres	33,099			33,099	32,100
	V-P Sales	65,600			65,600	29,349
	Res. & Dev. Dir	31,100			31,100	31.100
Total payments to all officers and directors					228,030	183,299
Philco	Pres	75,000	99,000	27,768	201,768	187,827
	Ex V-P	60,000	80,000	22,342	162,342	150,831
	Chm	50,000		7,978	57.978	56,918
Total payments to all officers and directors					1.9 million	1.7 million
RCA	Chm	200,000			200,000	200,251
	Pres	165,000			165,000	165,251
Sentinel	Pres	25,000		1.388	26,388	39.297
	V-P	17,500	22,500	5,063	45,063	33.598
Total payments to all officers and directors					109,398	100,080
Westinghouse	Pres	203.250			203,250	203,250
	Ex. V-P	125,000			125.000	125,000

ELECTRONIC manufacturers, like other companies with securities listed on stock exchanges, are required to file reports and proxy statements with the Securities and Exchange Commission.

In the reports, firms list the payments made to officers who receive more than $30,000 a year. The SEC defines an officer as a president, vice-president, treasurer, comptroller, or any person who performs functions corresponding to those performed by such officers.

▶ **Changes**—Figures for the companies sampled indicate that, in general, officer payrolls for radio and tv manufacturers increased substantially in 1953. However, for a number of firms, payments to top officers remained at 1952 levels. In some cases, where payments decreased, stock-sharing plans have been substituted. In companies where total payments to all officers and directors were higher in 1953 than in 1952 despite no increases for top officers, enlarged staffs or increased salaries for lower-echelon officers may have accounted for the change.

For the twelve set makers covered, payment increases to top officers listed averaged $19,000 from 1952 to 1953. The scale of increases was wide, however, ranging from $1,000 to $82,000 for any individual.

(Continued on page 10)

only Sprague makes them all!

YOU CAN CHOOSE FROM 5 DIFFERENT STYLES OF TANTALEX* CAPACITORS

Looking for tantalum electrolytic capacitors? You'll save time and trouble by checking Sprague's complete selection *first*. Sprague makes more types of tantalum capacitors than *any other manufacturer*.

Sprague Tantalex capacitors provide maximum capacitance in minimum space . . . exhibit no shelf aging under long testing periods . . . have extremely low leakage current. And most important, they give unusually *stable* performance, because they're made with tantalum, the most stable of all anodic film-forming materials.

There's a complete range of sizes and ratings available in Tantalex capacitors . . . from the ultra-miniature 10 mf, 4 volt unit in a case only ⅛" in diameter by 5/16" long . . to the 7 mf, 630 volt unit in a case 1⅛" in diameter by 2 19/32" long. As for case styles, Sprague makes them all, from tiny tubular and cup units to the large cylindrical types.

For complete details relating to your miniaturization or high temperature problems, write Sprague Electric Co., 35 Marshall St., North Adams, Mass.

Sprague, on request, will provide you with complete application engineering service for optimum results in the use of tantalum capacitors.

NEW! TYPE 101D for low-cost transistor circuitry

Especially useful for filter, coupling, and bypass applications in transistor electronics, these foil type miniature Tantalex capacitors were intended for use in hearing aids, pocket radios, and similar uses. Operating temperature range is —20 to +65°C. Request Engineering Bulletin 353.

NEW! TYPE 102D for −55°C to +85°C operation for military use

Here are tubular capacitors hermetically sealed in cases of silver plated copper. Intended for applications from 3 to 150 vdc, their small capacitance drop-off at extremely low temperatures, extremely low leakage current, and low power factor are of particular interest. Request Engineering Bulletin 351.

NEW! TYPE 103D ultra-miniature capacitors for transistor circuitry

Only ⅛" in diameter, and from 5/16" to ½" in length, these are the smallest electrolytics made. Providing relatively large values of capacitance in the very minimum of space in bypass, coupling, and filter applications, they are ideally suited for transistor hearing aids and military amplifiers in which small size is all-important.
Request Engineering Bulletin 352.

NEW! TYPE 104D miniature "cup" capacitor for military use

These low-voltage units consist of a sintered porous tantalum anode housed in a miniature silver thimble, which serves as both cathode and container for the electrolyte. Volume is less than 1/10 cubic inch; operating temperature range —55 to +85°C, and up to 100°C with a voltage derating of 15%. Request Engineering Bulletin 354.

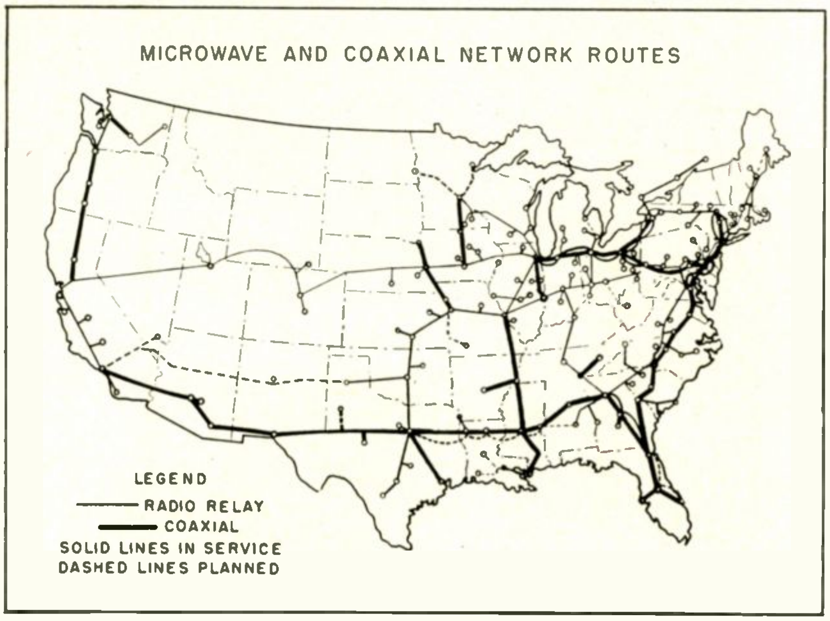
TYPE 100D for −55 to +125°C operation for military use

These hermetically sealed capacitors are available in voltage ratings up to 630 volts at 85°C or 560 volts at 125°C. They are of the sintered porous tantalum anode type, with internal construction to withstand high g shock, severe vibration, and thermal cycling. Request Engineering Bulletin 350A.

WORLD'S LARGEST CAPACITOR MANUFACTURER **SPRAGUE**

*Trademark

Export for the Americas: Sprague Electric International Ltd., North Adams, Mass. CABLE: SPREXINT



Television Network Facilities

More than 54,000 channel miles of coaxial cable and radio-relay facilities provide 300 stations in 191 cities in the United States with network television. Distances between microwave towers average about 30 miles, depending on topography. A relay system has a capacicty of 12 channels, six in each direction. Each channel can carry one television program

Model Business Goes Electronic

THE MANUFACTURE of transmitters and receivers designed for control of model planes is a small but growing segment of the electronics business. Many are companies wholly devoted to producing for the hobby field, but some have been supplying guidance equipment for Armed Forces small target drones.

At present, radio controlled models are operated on three major frequencies: 465 mc and 27.255 mc under the FCC Citizens Radio Service, and the 50 to 54 mc band. The latter requires an amateur operators license.

Equipment designed for operation at 465 mc is critical, complex and expensive. In addition, FCC rulings require that 465-mc transmitters be type-approved and sealed to prevent tampering.

Airlines Consider Radar Eye

Lightweight radar for commercial airlines permits crew to see weather and obstructions 150 miles ahead

AIRBORNE RADAR that sees storms, indicates obstructions and weighs less than a passenger makes sense to operators of commercial airlines. They have been watching development of a lightweight equipment known to the military as APS-42. Bendix Radio has recently demonstrated a modified civilian version known as the RDR-1. Two operators, so far, like it enough to use it.

Pan American-Grace Airways has authorized installation of the new radar eye in its fleet of DC-7's. Pan American World Airways will try one out in a DC-6.

▶ **What It Shows**—Operating on so-called X-band (3.2 centimeters) the radar is sensitive to obstacles the size of raindrops. It can spot a one-mile hole between two storms at twenty miles. On the ppi screen, the heaviest rainfall appears as a black spot surrounded by a white fringe of lesser precipitation.

Besides giving a view 240 degrees wide 150 miles ahead, the radar can be tilted up or down 15 degrees to search for higher aircraft or to map the ground. Circular lines on the scope indicate distance from the center, which represents the position of the plane.

▶ **Payload Reduction**—For what it does, the little radar costs only 136 pounds of payload. It comprises an antenna scanner mounted in the nose, a control unit and two indicator scopes in the cockpit, a synchronizer with power supply and transmitter-receiver both of which are mounted in the radio rack.

Equipment Makers Push Color Sales

Broadcasters ready plants for network feed, plan local films and slides

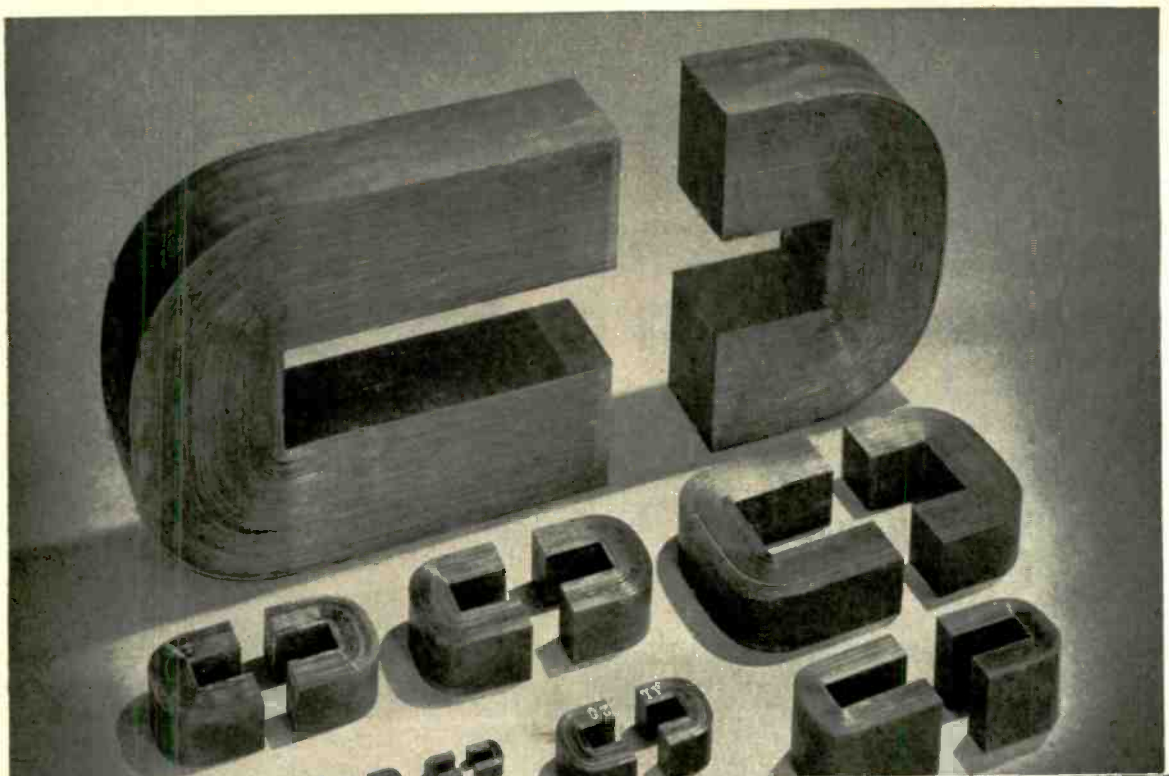
COLOR television is here, insofar as New York and Los Angeles viewers are concerned. Metropolitan dailies now list colorcasts on their television program pages. These are live shows originating at network key stations.

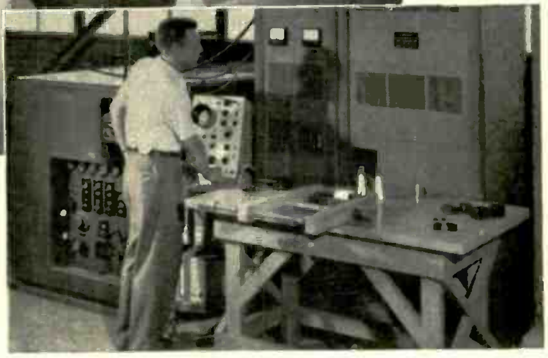
Color will come to the rest of the country by way of network feed and locally originated films and slides. At present 42 stations in 29 cities are equipped to handle network color. By the year's end 130 stations in 96 cities should be so equipped.

▶ **Equipment**—It will cost the station owner between $50,000 and $100,000 to convert his plant to color. This includes special test equipment, stabilizing amplifiers, transmitter modifications where required and film and slide equipment.

Du Mont, Philco, RCA and GE

(Continued on page 12)





Arnold Pulse Transformer Cores are individually tested under actual pulse conditions

W&D 5238

WRITE for your COPIES

"MAGNETIC MATERIALS CATALOG"

General information on all Arnold magnetic materials: permanent magnets, tape-wound and powder cores, types "C" and "E" cut cores, etc.

"ARNOLD SILECTRON CORES"

52 pages of valuable data covering a complete range of core shapes, sizes, tape gauges, etc.

ADDRESS DEPT. E

The inset photograph above illustrates a special Arnold advantage: a 10-megawatt pulse-testing installation which enables us to test-prove pulse cores to an extent unequalled elsewhere in the industry.

For example, Arnold 1 mil Silectron "C" cores—supplied with a guaranteed minimum pulse permeability of 300—are tested at 0.25 microseconds, 1000 pulses per second, at a peak flux density of 2500 gausses. The 2 mil cores, with a guaranteed minimum pulse permeability of 600, receive standard tests at 2 microseconds, 400 pulses per second, at a peak flux density of 10,000 gausses.

The test equipment has a variable range which may enable us to make special tests duplicating the actual operating conditions of the transformer. The pulser permits tests at .05, .25, 2.0 and 10.0 microsecond pulse duration, at repetition rates varying anywhere from 50 to 1000 pulses per second.

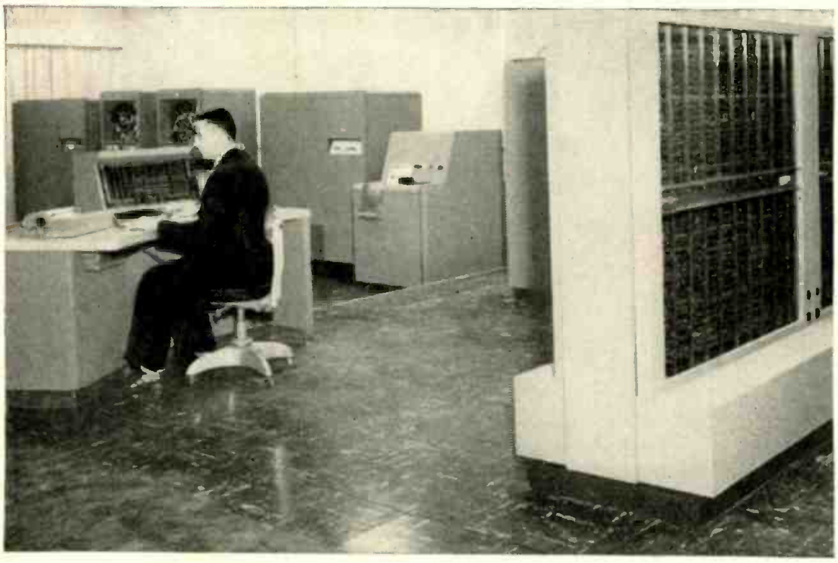
This is just another of Arnold's facilities for better service on magnetic materials of all description. ● Let us supply *your* requirements.

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION
General Office & Plant: Marengo, Illinois
DISTRICT SALES OFFICES . . . New York: 350 Fifth Ave.
Los Angeles: 3450 Wilshire Blvd.
Boston: 200 Berkeley St.

are all offering film and slide originating equipment. The GE unit utilizes the CBS-developed Chromacoder. The RCA equipment uses three Vidicon cameras. The Philco scanner can handle both 16 and 35-mm film. Du Mont, Philco and GE use the flying-spot principle.

Computer to Reduce Payroll Work



Unitized computer is made up of arithmetic and logical units, input and output equipment and memory units as required by specific application

A COMPUTER designed for business use in accounting, payroll and inventory work has added another area to the growing fields of computer application. Insurance companies, banks and other businesses handling statistics and accounts on a large scale are expected to be the major markets for the new unit.

Scheduled for production in January 1955, the IBM model 702 computer will be leased at a figure in the neighborhood of $25,000 per month. The 702 uses magnetic tape or punch cards for programming and has an electrostatic memory consisting of 70 cathode-ray storage tubes. Magnetic-tape storage units provide additional memory space if required. Output can be in the form of punch cards at the rate of 100 per minute.

Use of the computer in a typical payroll operation reduces the number of steps from 302 in customary accounting methods to 28. In this example cost of the work would be reduced from $4,000 to $1,935.

▶ **Computers in Use**—IBM estimates that the number of their earlier model computers now in use or on order is in excess of 5,500. Most of the four models that have been produced are being used in scientific and engineering research.

Reminder To Reader

If this issue of ELECTRONICS has come to your home or to the place at which you work, you are reading it only because you, or someone in your behalf whose name is on our circulation records, has paid a subscription-price for ELECTRONICS' service to you as a reader.

The payment underwrote a judgment that ELECTRONICS would help you in your work.

It placed ELECTRONICS under a contract to do that.

Renewal of such a contract, on the original terms at the end of the subscription period, is wholly a reader-decision that ELECTRONICS has not failed.

The publisher of ELECTRONICS believes that the controlling interest of the reader demands and deserves that he hold this kind of a contract, which can be provided only under the principle of voluntarily renewable paid-subscription service.

H. W. MATEER
PUBLISHER

Anne Track Speeds Messages

Multichannel radio link combines compact equipment with eventual dollar savings

NEW FIELD RADIO equipment developed by Bell Labs is now coming off Western Electric production lines in quantity. With a nearly pronounceable military designation AN/TRC-24, it is customarily referred to as Anne Track Twenty-Four. Its purpose is to provide multichannel radio communication linking positions up to 25 or 30 miles apart.

Cascading equipments in multilink fashion provides moderately long-distance telephony. Alternatively, one or more links can be interposed between sections of a comparable wire carrier system using spiral-four cable.

In the transmitter and receiver, frequency modulation is used at carrier frequencies over the range 100 to 400 mc. The equipment accommodates a signal band from 250 to 68,000 cycles.

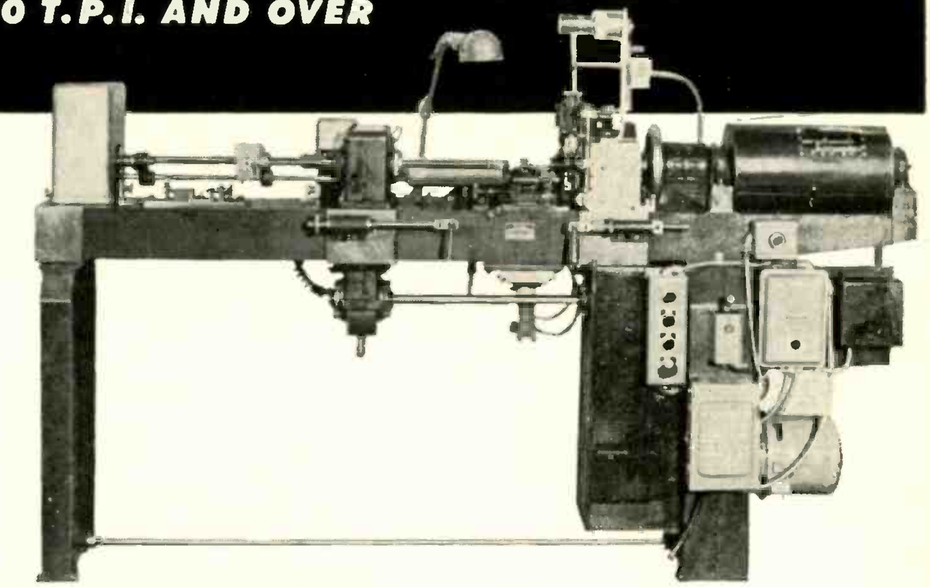
▶ **The Economics**—It is difficult to compare this new equipment with that used in World War II because there was nothing exactly like it. The nearest approach was many times as bulky and several times as expensive. Since the requirements of all military groups was represented by the Signal Corps in guid-

(Continued on page 14)

NEW SUPER-DRIVE GRID WINDER

FOR HIGHER PITCH PRECISION

TO 500 T.P.I. AND OVER



THE PROBLEM:

to produce grids of higher pitch and top precision at greater speed . . . and, at the same time, to cut labor and maintenance costs.

THE SOLUTION:

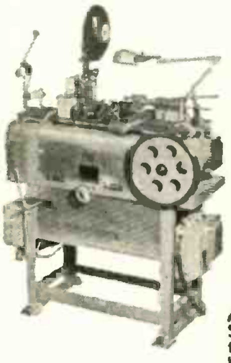
Kahle developed a grid winder with extra heavy, oversize parts to provide greatly increased smoothness and sensitivity of operation. Vibration was cut to a new low by carrying main and draw spindles on extra large bearings, by using flexible couplings and by replacing ratchet and pawl with gears. Lubrication is fully automatic requiring nothing more than occasional attention to the oil level.

Kahle HIGH SPEED AUTOMATIC GRID WINDING MACHINE

NEW EXCLUSIVE FEATURES INCREASE PRODUCTION SPEED AND PRECISION

- spool carriage rides in its own two bearings and is dynamically balanced
- main and draw spindles are extra long; each mounted on two individual bearings
- double-row precision bearings are pre-loaded, extra large, anti-friction
- lubrication is provided by the Bijur fully automatic system
- mandrel head, draw spindle and cam shaft drives are sealed and run in an oil bath
- lead screw and nut are never disengaged, assuring exact register at all times
- exclusive gear and clutch arrangement operates instantly at a flick of the finger
- pneumatic cutter rises, cuts and recedes automatically leaving mandrel completely accessible
- tension control of grid wire spool is a special hysteresis-magnetic brake
- cutting, notching, peening knives are easily adjustable to micrometer precision
- side wire (mica-stop) swaging
- smooth leg gapping; constant and variable pitch
- operates at 1000 rpm, both right and left hand
- makes grids up to ⅞" diameter or width.

Kahle specializes in equipment for manufacturing sub-miniature, miniature, power and cathode-ray tubes.



NEW
#2018
Automatic
Filament
Tab
Welding
Machine

Ask about #1979 Seal-Ex (Automatic Sealing Exhaust Machine) and #1934 Automatic Bulb Making Machine for round or flat sub-miniature bulbs.

WRITE TODAY FOR COMPLETE SPECIFICATIONS AND PRICES

KAHLE ENGINEERING CO.
1327 SEVENTH STREET • NORTH BERGEN, NEW JERSEY

Specialists in high-speed electronic tube machinery for over 40 years ing the development, other services will employ the equipment, making for greater potential speed of all armed forces and reducing costs through standardization.

Broadcasters Attend Biggest Confab

NARTB membership turns out in force to get low-down on colorcasting

MORE than 2,500 broadcasters representing every state in the union, Hawaii, Alaska, Canada, Mexico, Cuba and other points jammed Chicago's Palmer House in May as the National Association of Radio and Television Broadcasters held their 32nd annual conclave.

Present were six of the seven FCC commissioners including Rosel Hyde, acting chairman. More than 100 exhibitors maintained displays. Station equipment on the main exhibit floor was valued at more than $4 million. About a third of the exhibitors were manufacturers or distributors of studio and transmitting equipment. The remainder were station reps, film and record companies and publications.

▶ **Technical Session**—Concurrent with the management conference was the 8th annual engineering conference. The 26 technical papers presented constituted a broadcast engineer's short course in color television. Color likewise was much in evidence on the exhibit floor with four companies showing film scanners, two live shows in progress and assorted items of color test equipment spread about.

Other equipment on display included a 50-kw a-m transmitter and 50-kw vhf television rigs, microwave relay links readied for color and uhf transmitters ranging from 1 kw upwards.

▶ **Business**—Underlying theme of the convention, however, was the uhf problem. Other subjects of interest included remote operation of a-m stations, ways to make profits from f-m and opposition to threatened advertising bans.

MARIE S. MORAN

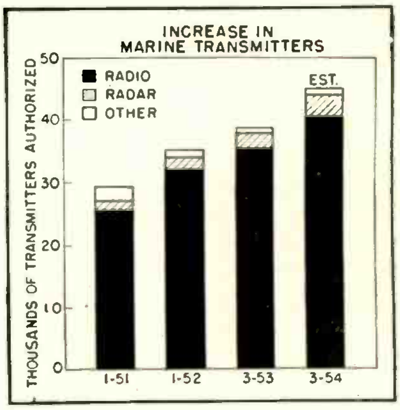
RADAR is adapted to a bridge-ducking tug as . . .

Waterborne Equipment Sales Rise

Radio and radar volume increased substantially last year as shippers took to the air

AMOUNT of electronic equipment used in the marine service has increased steadily thoroughout the past three years. As is shown in the chart, radio transmitters for two-way communication between coast stations and ships along with radar equipment have accounted for over 95 percent of unit sales to the field. Remaining sales have nearly all been for land or fixed station transmitters.

▶ **Market**—Under the Communications Act all cargo vessels of 1,600 or more gross tons and all passenger vessels navigated in the open sea are required to carry radiotelegraph installations unless exempted by the FCC under certain conditions. International regulations require that cargo vessels between 500 and 1,600 gross tons on international voyages be equipped with either radiotelegraph or radiotelephone. Regulations also require lifeboats of specified type ships to carry automatic transmitter-receiver units. A large number of vessels on the Great Lakes are also equipped with radiotelephone installations.



▶ **Companies**—Mackay has reported that complete radio and electronic equipment was being supplied for a fleet of 22 new tankers and that similar equipment was installed aboard many vessels for the U. S. government. The company's portable lifeboat set was ordered for 600 ships during 1953. Sixty new ships were equipped during the year with complete radio stations and over 200 more were converted to international standards and work was done on 300 rental contract ships.

Radiomarine Corporation has re-

(Continued on page 16)

for control of

SHOCK and VIBRATION

BARRY B MOUNT

They're YOUR designers - but WE pay them.

You don't have shock and vibration problems every day — but when you *do*, you want them solved promptly. So you want the practical experience of men who've been spending *all* their time in this highly specialized engineering — men who have most likely met and successfully answered questions just like the ones that are bothering you. These men are Barry engineers — ready and able to analyze *your* shock and vibration problems, backed by a laboratory staffed and equipped to *prove* their solutions, and served by model shops geared to produce *your* prototypes whenever you need them.

You'll save time, money, and trouble by using our design and prototype service. Write today for Bulletin DP-54 "This is Barry".

PRODUCTION FACILITIES include such modern equipment as this 100 KVA spot welder, accurately timed for welding aluminum.

LAB-TESTING the performance of Barrymounts protecting delicate electronic equipment.

THE BARRY CORP.

707 PLEASANT STREET
WATERTOWN 72, MASS.

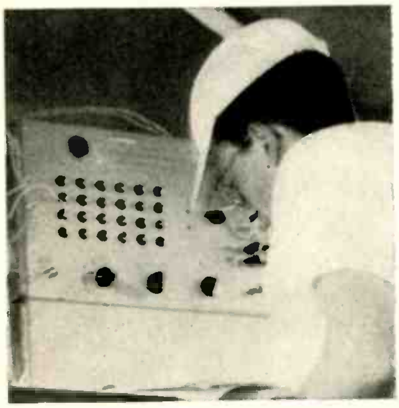
SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES ported a 57-percent increase in sales in 1953 over 1952 volume. Repeat orders for specialized electronic units helped swell sales to the armed forces and other government procurement agencies to more than twice the volume of the previous year. Some of the increases in the firm's sales were due to diversification, however, and some new products made by the division were not in the marine field.

Installations of radar were made by the firm on more than 100 ships operating on the Great Lakes and a similar number that sail on other inland waterways. About 34,500 marine service calls were answered in 1953 by the firm.

Raytheon reports that about 2,100 commercial ships are equipped with its radar. Approximately 35 percent of the firm's commercial product sales were to the marine field in 1953. The same percentage is expected for 1954.

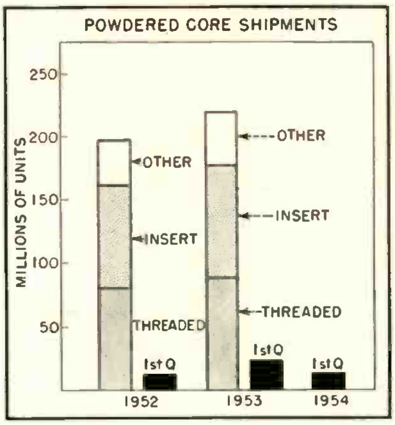
Radar is being actively adapted and sold in the tug-boat field. Recent adaptation of Raytheon radar equipment has transmitter and receiver built entirely within the antenna housing so that the tug can lower her mast and retract her wheelhouse seven feet to duck under low bridges. No rigid waveguide is used in the installation.

Electronics Gages Sports Car Speed



Auto speeds in hundredths of a mile per hour were checked at the National Sports Car Races by Naval Ordnance Laboratory engineers through use of two pickup units, exactly 100 feet apart, consisting of 450-mm lenses with phototubes in the focal planes and a Potter megacycle frequency-time counter shown above

Powdered Iron Cores Gain Sales



Shipments to the industry have risen steadily and applications are increasing

IMPORTANCE powdered iron cores have gained in the electronics business was pointed up at the recent tenth annual meeting of the Metal Powder Association.

Sessions concerning electronic cores were held for a full day in which manufacturers of receivers, cores, coils and coil forms discussed the product.

A program of standardization was adopted to bring about reduced costs of the components to set manufacturers. According to the association, the return of a buyer's market has emphasized and heightened the need for standardization.

▶ **Market**—The sales field that the electronics industry represents to core makers is indicated in the chart. Over 217.5 million cores of all types were shipped for use in electronic equipment last year compared to approximately 197 million in 1952. Insert cores, those in which a metal insert is molded or cemented in one or both ends of the core, comprised the largest shipments in both 1952 and 1953 with 81.8 million units and 89.0 million units shipped respectively. Such cores are used to adjust an inductor to a fixed frequency.

Threaded cores were next largest in use with shipments for electronics use totalling 79.3 million units in 1952 and 87.1 million units in 1953. The remaining core shipments in 1953 were made of 11.7 million tuning cores which is a side or end molded iron core for continuous permeability tuning with an insert cemented or molded into it; 8.0 million of the coil form which is an iron core formed with wire leads at both ends (for peaking coils), and 21.5 million of the special and miscellaneous types of cores.

▶ **Sales**—For the first quarter of this year, iron core shipments to the electronics industry have been below the first quarter of 1953 mainly because of lower radio and tv production. Military use of the cores has dropped off and comprised only 10 percent of the total cores shipped for electronics in the first quarter.

In the first quarter of 1953 they accounted for 12 percent of shipments and in 1952's first three months, 29 percent was for military electronics. For the full year of 1953, the military took 9 percent of shipments compared to 21 percent for all of 1952.

▶ **Future**—Despite lower production in the first quarter of this year, core manufacturers expect increasing business. They feel that although the industry is in a buyer's market for the first time since the war, the utilization of metal powders will continue to grow despite and perhaps because of an increase in general business competition.

Advisory Board Points Up Nickel Conservation

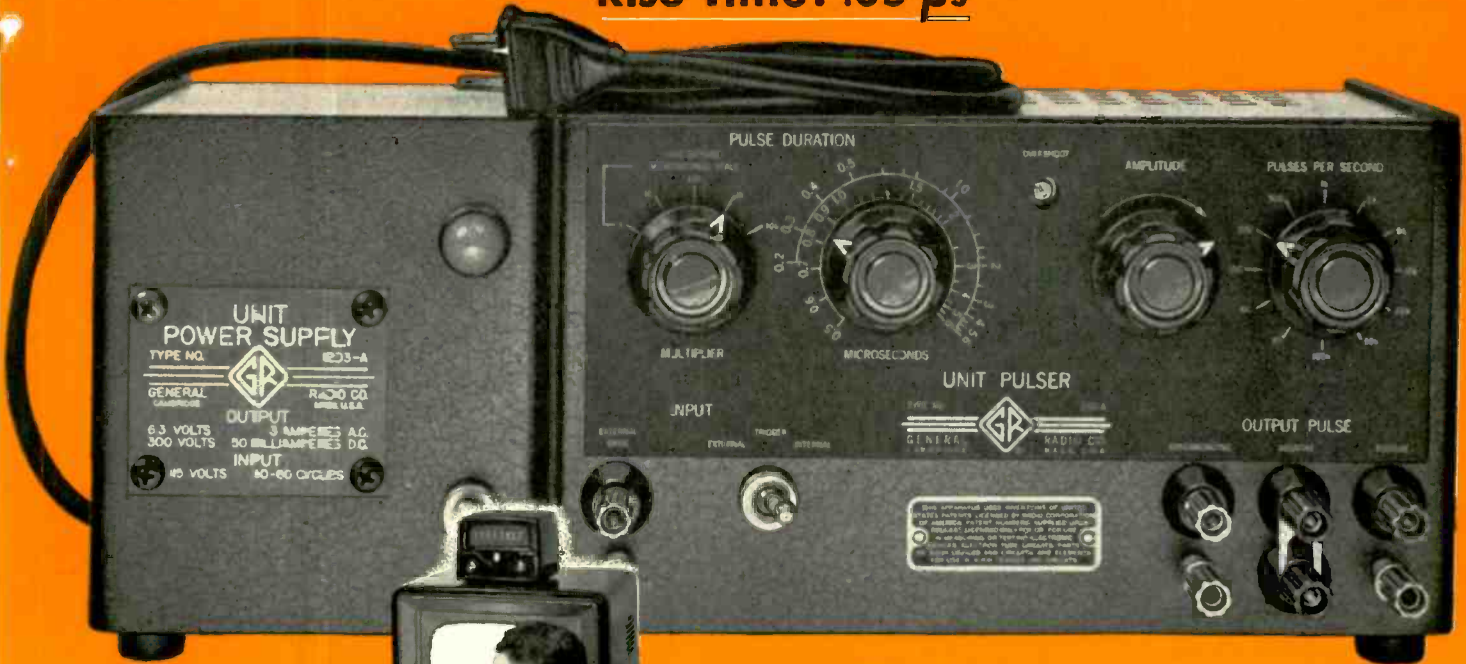
Tight nickel supplies and possible increased demands color supply picture

DESPITE recent reports that 10 percent more nickel would be available for civilian uses because of lighter military requirements, the government is still concerned about the supply picture for the metal. A recent report by the Material Ad-

(Continued on page 18)

Announcing G-R's NEW Unit Pulser

Pulse Durations: 0.2 to 60,000 μs
Repetition Rates: 0 to 100 kc
Rise Time: .05 μs



Type 1217-A Unit Pulser $225
shown with plug-in **Type 1203-A Unit Power Supply $40**

Pulse-modulated UHF signal sent through tv-convertor, into tv-set antenna-input, and through tv-set to screen — overall transient response from front to end determined quickly and easily — convertor and receiver manufacturers may in this way effectively determine ability of their products to pass uhf signals, under simulated operating conditions.

The Type 1000-P7 Balanced Modulator Is A Unique New Device Which Permits Full 100% Amplitude Modulation Of Carriers From 60 to 2300 Mc — Modulating Signal May Be Any Frequency Over 0 to 20-Mc Band.

Where good rise time characteristics and negligible incidental f-m *are essential*, these instruments are highly recommended.

With the Unit Pulser and this Modulator, signal generators may be pulse modulated over extremely wide ranges. The two instruments make a highly useful combination for pulse work . . . such as testing of television broadcast and receiving equipment . . . and measurements on radar, omni-range and DME, and telemetering apparatus.

The Type 1217-A Unit Pulser is the first *laboratory-quality* pulse generator to be made commercially available at *moderate cost*. Its wide range of pulse durations and repetition rates, stability, high output voltage and variable amplitude control make this instrument a highly versatile piece of equipment for every industrial and college laboratory.

The GR Unit Pulser . . . *Small . . . Compact . . . Economical*

Provides square waves from 10 cycles to 100 kc for checking Overall Audio-Amplifier Transient Response.

For TV-Receiver Testing — a Unit Pulser locked to the receiver line frequency produces a visual response directly on the picture tube in checking operation of video detector and amplifier.

Invaluable in Educational Laboratory and Demonstration Class — an Oscillocope and Unit Pulser may be used in student experiments to illustrate ability of linear, passive networks to pass pulses of varying durations and repetition rates.

Useful in Telemetering, Computing and Nuclear Research and Development — Pulser produces clean pulses controllable over wide ranges — combination of two Pulsers produces a flexible phasing system and source of delayed pulses or gates adjustable with time.

Write for the recently published VHF-UHF Bulletin which gives specifications and technical details for the new Unit Pulser, the Balanced Modulator, and G-R's completely integrated line of high-frequency equipment.

Since 1915 — GR

Manufacturers of Electronic Apparatus for Science and Industry

GENERAL RADIO Company
275 Massachusetts Avenue, Cambridge 39, Massachusetts, U. S. A.
90 West Street NEW YORK 6   920 S. Michigan Ave. CHICAGO 5   1000 N. Seward St. LOS ANGELES 38

Admittance Meters ☆ Amplifiers ☆ Coaxial Elements ☆ Distortion Meters ☆ Frequency Measuring Apparatus ☆ Frequency Standards ☆ Impedance Bridges ☆ Light Meters Megohmmeters ☆ Modulation Meters ☆ Polariscopes Precision Capacitors ☆ Oscillators ☆ U-H-F Measuring Equipment ☆ Parts & Accessories ☆ Signal Generators Wave Analyzers ☆ Variacs ☆ TV & Broadcast Monitors Pulse Generators ☆ R-L-C Decades ☆ R-L-C Standards ☆ Unit Instruments ☆ Sound & Vibration Meters ☆ Stroboscopes ☆ Null Detectors ☆ Motor Controls ☆ Wave Filters ☆ V-T Voltmeters visory Board of the National Academy of Sciences to the Defense Department recommended additional research on conservation means.

▶ **Recommendations**—The Board listed several possible ways to conserve nickel in the manufacture of communications equipment. They are:

Substitution of 10-percent nickel silver for 12-percent nickel silver in parts other than springs. Substitution of zinc-plated steel for nickel silver. Substitution of chromium stainless steels (AISI 400 series) for nickel chromium stainless steel types (AISI 300 series). Further substitution of silicon steel for high nickel alloys in armatures and cores. Further reduction in the thickness of nickel plating under ceramic coatings. Complete elimination of nickel plating in such applications by substitution of special enameling steels.

▶ **Manufacturers**—Despite the supply problem, some electronic manufacturers report that they have felt no actual shortage of the metal. However they admit that nickel is tight. A few feel that if set production had not slumped off this year, a shortage might have developed.

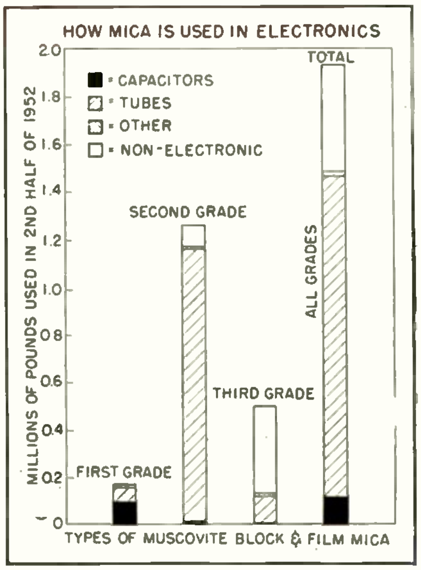
Nickel manufacturers see no overall shortage despite reports. They term the present situation spotty and say there is no shortage for rolled nickel but that in plating there are some shortages. They feel that the future is important and that the world situation and its effect on government and military nickel policies could change the supply situation overnight.

▶ **Consumption**—Over 200 million pounds of nickel are consumed in the U. S. annually. About 45 percent of the total is utilized in stainless and engineering alloy steels.

The electron tube industry uses about 3.5 million pounds annually, close to 300,000 pounds a month. In 1952 it was estimated by RETMA that the amount of nickel used in radio-tv set production was approximately 2.5 million pounds and that with conservation methods and lower production a 65-percent saving of nickel could be made.

Mica Fabricators Study Sales

The industry is a volume user of natural mica; synthetic mica enters the picture



ABOUT 19,000 tons of natural mica of all types are imported annually into the U. S.

According to the Bureau of Mines, about 3.8 million pounds of this block mica are suitable for electronic applications. India is our main source for mica of this type. It is estimated that approximately 50 percent of the high grade mica used in the U. S. comes from India, 45 percent from Brazil and only 5 percent from the U. S. But the beginning of commercial production of synthetic mica this year in the U. S. may change the mica import picture in the future. So far only small crystals have been produced but it is hoped that larger crystals will be forthcoming within two years.

▶ **Consumption**—Nearly 70 percent of the mica suitable for electronics is used in electron tubes, 6.4 percent is used in capacitors, 0.6 percent in other electronic applications and 23.0 percent in nonelectronic products such as flatirons, toasters, gage glass and telephones.

With the cooperation of the Mica Fabricators Association, the Bureau of Mines estimates that receiving tubes used 1.3 million pounds in the second half of 1952 while transmitting and radar tubes used 17,739 pounds. All other tubes used 20,374 pounds.

In receiving tubes, stained or second grade mica accounted for 1.1 million pounds of the total used. Transmitting and radar tubes also used more stained or a total of 14,859 pounds. Only for tubes of other types was first grade mica used to a greater extent, with a total consumption of 12,190 pounds. Capacitor manufacturers used mostly first and second quality film mica during the period.

Mica fabricators for the electronics industry enjoyed a good year in 1953 when nearly 4.0 million pounds of mica were used by manufacturers in the field.

Financial Roundup

VARIED profit picture was indicated in the financial statements reported in the past month by firms in the electronics field. Here are the net profits for 17 companies for monthly periods indicated in fiscal 1954 and 1953:

Company	Net Profit 1954	1953
Admiral 3m	$ 1,504,044	$ 3,056,878
Am. Cable & Radio 3m	476,106	238,799
Bendix Av. 6m	6,359,188	4,721,962
CBS 3m	2,866,365	2,338,148
Cornell-Dubilier 6m	847,953	895,204
T. A. Edison 3m	289,907	260,543
Electronic Eng 3m	18,153	
Emerson Radio 6m	947,515	1,768,694
General Inst. 12m	926,903	1,275,864
IT&T 3m	2,323,343	2,207,457
Magnavox 9m	2,030,912	2,051,578
Minn. Mining & Mfg. 3m	5,354,866	4,354,859
Philco 3m	2,438,000	3,401,000
Standard Coil 3m	406,306	1,737,045
Tung Sol 3m	450,304	552,318
Westinghouse 3m	26,286,000	16,858,000
Weston Inst. 3m	350,788	255,939

▶ **Securities**—Triad Transformer of Venice, Calif. filed with SEC covering 20,000 shares of common stock (par $5) to be offered at $10 per share. Proceeds are to be used to reduce bank loans and for working capital.

Tape Recording Corp. filed with SEC covering 15,000 shares of noncumulative preferred stock to be first offered at par ($1 per share) to common stockholders on basis of one preferred for each four shares of common. Net proceeds will be added to working capital.

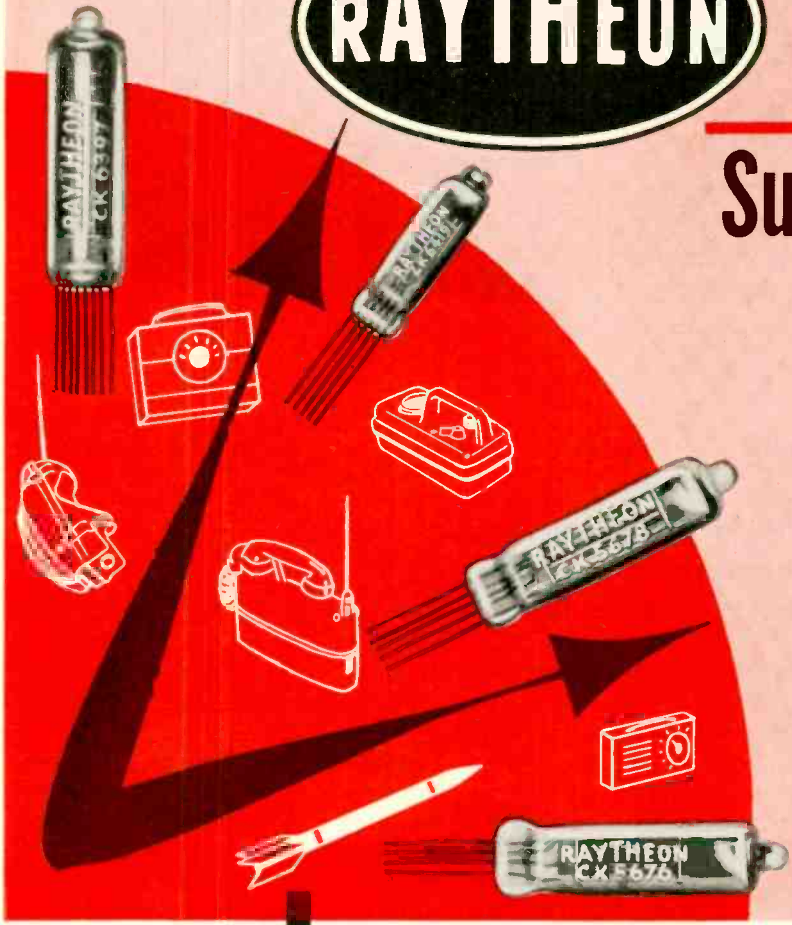
Control Engineering of Norwood,

(Continued on page 20)

TAKE JUST ONE MINUTE

to consider
the advantages of

RAYTHEON Filamentary Subminiature Tubes



There are many applications where filamentary subminiatures meet your requirements better than the familiar heater-cathode types. RAYTHEON Filamentary Subminiature Tubes have the dependability, life and performance required for critical applications:

Low Operating Power — total input as little as 6.5 milliwatts

Small Size — as small as 0.06 cubic inches

Negligible Heat To Dissipate

Rugged — up to 500G shock — standard fatigue vibration

Reliable Filaments — tests indicate only one failure per 500,000 on-off cycles

Quick Heating — well under a second

Low Microphonics — Raytheon CK512AX and CK6419 are extraordinary in this respect

Long Life — combined test data on all types show 58,000 hours of dependable performance for each failure

High Efficiency — mutual conductance (micromhos) as much as 4 times greater per watt of filament power as per watt of heater power in comparable heater-cathode tubes

Here are characteristics of a few representative types of Raytheon Filamentary Subminiatures. Complete data on all types are available on request.

TYPE	DESCRIPTION	Length (Inches)	Diameter (Inches)	FILAMENT		PLATE VOLTS	SCREEN VOLTS	GRID VOLTS	PLATE MA	SCREEN MA	MUT. COND. UMHOS	VOLTAGE GAIN	PLATE RESIST. MEG.
				VOLTS	MA								
1AD4	RF Pentode	1.50	.300-.400	1.25	100	45	45	Rg=2meg.	2.8	0.8	2000		0.5
1AG5	Diode-Pentode	1.50	.285-.385	1.25	30	45	45	Rg=5meg.	0.8	0.25	350		0.26
CK512AX	Ampl.-Pentode	1.25	.285-.385	0.625	20	22.5	22.5	-0.625	0.125	0.04	160	37	1.25
CK5676/6050	UHF Triode	1.50	.300-.400	1.25	120	135		-5.0	4.0		1600		
CK5678	RF Pentode	1.515	.300-.400	1.25	50	45	45	Rg=5meg.	0.8	0.22	820		1.2
CK6088	AF-RF Pentode	1.50	.285-.385	1.25	20	45	45	-1.25	0.65	0.15	625	†10.5	0.7
CK6092	AF Pentode	1.50	.285-.385	1.25	50	45	45	-4.5	1.4	0.4	600	†25	
CK6286	UHF Triode	1.50	.285-.385	1.25	125	67.5		-2.0	6.0		2100		
CK6397	RF Pwr. Pentode	1.60	0.40	1.25	120	125	125	-7.5	7.0	1.1	1800		
CK6418	AF Pentode	1.25	.235-.290	1.25	10	22.5	22.5	-1.2	0.24	0.06	300	†2.2	0.42
CK6419	Ampl. Pentode	1.25	.235-.290	0.625	10	15	15	-0.625	0.0046	0.002	17	27	12

†Power output — milliwatts

RAYTHEON

RAYTHEON MANUFACTURING COMPANY

Excellence in Electronics

Receiving Tube Division — Home Office: 55 Chapel St., Newton 58, Mass.

For Application Information Call: Boston, Bigelow 4-7500 ● Chicago, NAtional 2-2770 ● New York, WHitehall 3-4980 ● Los Angeles, Richmond 7-4321

RAYTHEON *MAKES* ALL THESE:

RELIABLE SUBMINIATURE AND MINIATURE TUBES • SEMICONDUCTOR DIODES AND TRANSISTORS • NUCLEONIC TUBES • MICROWAVE TUBES • RECEIVING AND PICTURE TUBES

Mass. offered an issue of $300,000 6% subordinated convertible debentures due April 1, 1964 at 100 percent. Net proceeds are to be used for general corporate purposes, including additional working capital largely for the promotion of commercial and industrial use of the firm's present instruments and for the development of new products and markets.

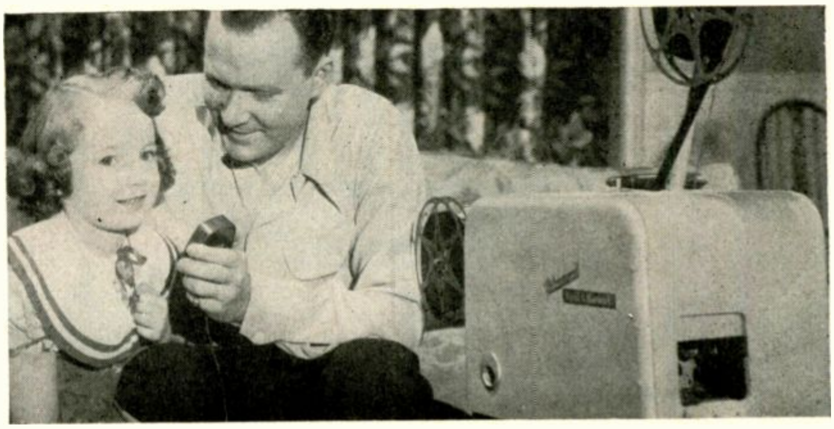
Daystrom is requesting holders of capital stock of Weston Instrument to submit tenders for the purchase by Daystrom of up to 55,000 shares of the capital stock of Weston at a price of $25 per share.

Hoffman Radio registered with SEC covering 130,000 shares of its common stock, 50 cents par. Net proceeds are to be added to working capital. The firm intends to build a new $1.5 million plant in El Monte, Calif.

Firms Alive to Tube Replacement Business

SMALL manufacturers seeking a piece of the lucrative tube replacement market have concentrated on specialty items. For example, fringe-area televiewing and large-screen sets seem to have created a special market for souped-up versions of the type 5U4 low-voltage rectifier. An additional output of 20 to 40 volts often makes it attractive to replace the conventional rectifier with one drawing a third more filament current. Some bigger companies have their own higher-current tubes, too, with special construction and new type numbers.

▶ **One Answer**—One manufacturer's approach to a competitive situation is a complete redesign of several popular tubes found in many television sets. General Electric is now offering its new, interchangeable versions of the 5U4, 6BQ6 and 6SN7. The line will also include 25BQ6, 1B3 and 5Y3. Mechanical improvements claimed for various new tubes are bottom-stem bases, higher melting-point solder and different glass envelopes. On the electrical side, maximum plate voltage for the new 6SN7, for instance, is 200 volts above the old rating—500 volts.



MAGNETIC striping gives excellent results on 16-mm film as . . .

Home Movies Sound Off On Tape

System using tape recorder and silent projector may replace magnetic striping on film

SOUND with home movies has been the goal of practically all 8-mm and 16-mm amateur enthusiasts. Introduction of magnetic striping on the side of movie film attracted much interest, but the method requires adding a magnetic sound head on the projector and separate processing of film for applying striping.

Normal expansion and contraction of film with temperature and humidity tended to crack off the striping. Laminated striping cured this.

▶ **Market Figures**—There are some 3,000,000 movie makers in this country, of which about 600,000 use 16-mm film and 2,400,000 use 8-mm film. Magnetic striping is considered satisfactory only for the 16-mm enthusiasts, because there is not enough room on 8-mm film to get sufficient powder for adequate fidelity.

▶ **New Technique**—An electronic control system being patented by E. Anthony of Long Island, permits use of a standard two-track magnetic tape recorder with any movie projector to achieve synchronized sound. Ordinary tape and ordinary film are used, with no extra processing whatsoever. Synchronization is always accurate to the spacing between adjacent sprocket holes. The simple attachments required on the recorder and projector can be put on in a few minutes and connected to the electronic control chassis. Installed cost of control unit and accessories is expected to be about $100.

The user feeds sound to the recorder while watching the projected film. Control signals are recorded automatically on the other track of the tape, for insuring correct projector speed during playback. For lip synchronization with sounds recorded during filming, as required for many industrial films and for catching baby's first words, a pickup device can be added to the camera in some cases.

▶ **Striping Systems**—Lowest-priced 16-mm magnetic recording projector in the Bell & Howell line retails at approximately $700. With this, amateurs can add sound to movies for 3½ cents a film foot, the cost of striping magnetic material on the film edge.

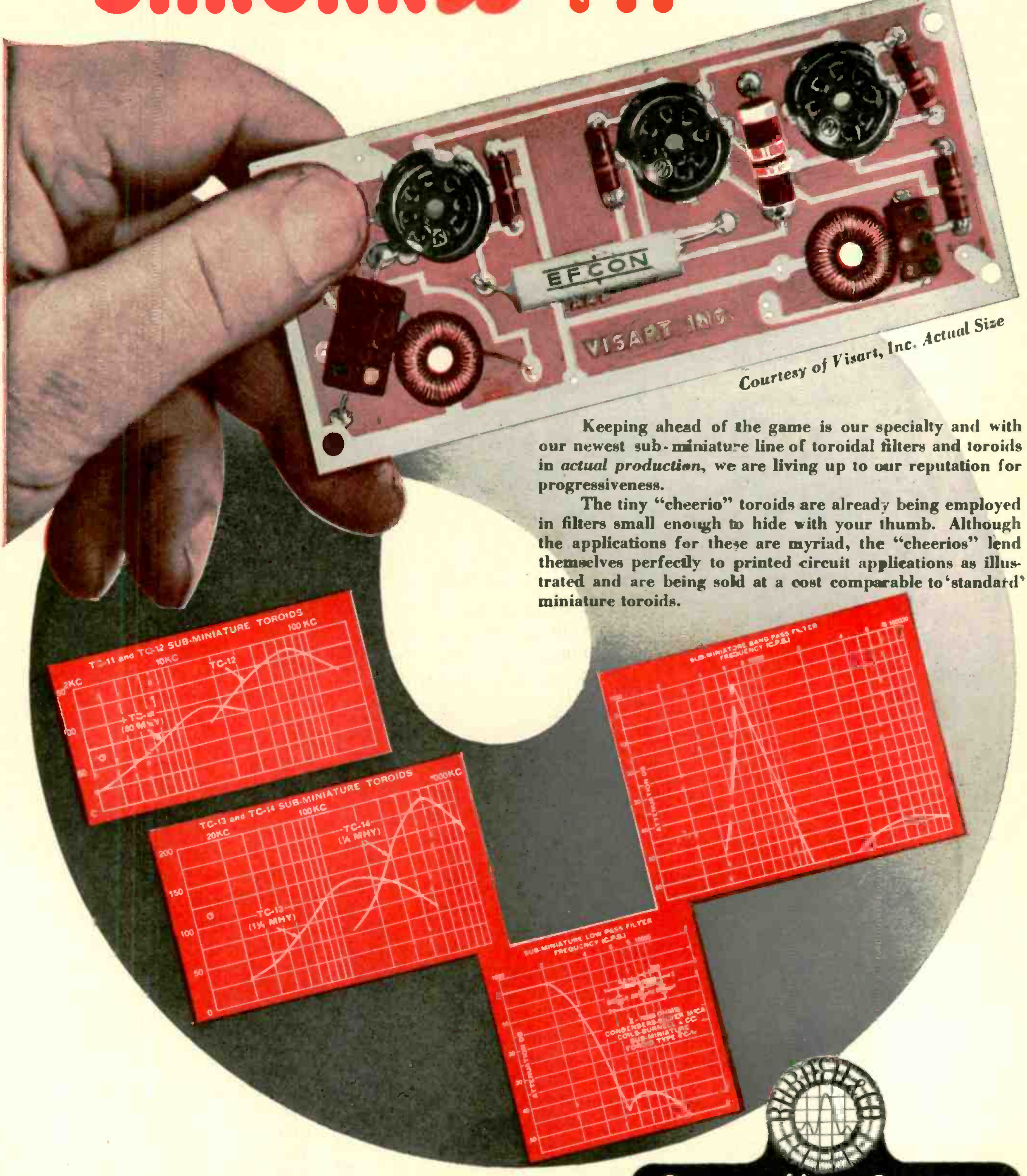
Ampro makes an 8-mm silent projector designed to take magnetic sound track when and if it becomes inexpensive enough to interest the 8-mm enthusiasts. Cost of converting this for sound has not yet been determined. Ampro also makes 16-mm optical-magnetic sound projectors starting at $720.

Victor Animatograph provides a magnetic sound attachment retailing at about $200 for its 16-mm

(Continued on page 22)

Burnell TOROIDS and FILTERS

"SHRUNK *to* FIT"


EFCON
VISART INC.
TC-11 and TC-12 SUB-MINIATURE TOROIDS
TC-12
TC-13 and TC-14 SUB-MINIATURE TOROIDS
TC-14 (¼ MHY)
TC-13 (1¼ MHY)
SUB-MINIATURE BAND PASS FILTER FREQUENCY (C.P.S.)
SUB-MINIATURE LOW PASS FILTER FREQUENCY (C.P.S.)
ATTENUATION DB

Courtesy of Visart, Inc. Actual Size

Keeping ahead of the game is our specialty and with our newest sub-miniature line of toroidal filters and toroids in *actual production*, we are living up to our reputation for progressiveness.

The tiny "cheerio" toroids are already being employed in filters small enough to hide with your thumb. Although the applications for these are myriad, the "cheerios" lend themselves perfectly to printed circuit applications as illustrated and are being sold at a cost comparable to 'standard' miniature toroids.

Write for new and enlarged 16 page catalog 102A

Exclusive Manufacturers of Communications Network Components

Burnell & Co., Inc.
YONKERS 2, NEW YORK
CABLE ADDRESS "BURNELL"

projectors. The magnetic head is rated for at least 1,000 hours of use.

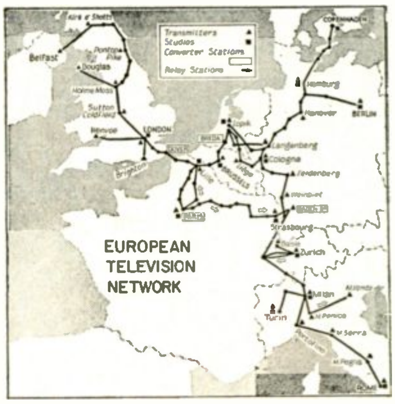
Magnetic laminate tape with a thermoplastic adhesive for bonding to film either before or after processing is made by Minnesota Mining. Costs are competitive with liquid striping, being about 2½ cents a foot for 16-mm film and $1.75 per 50 feet of 8-mm film at one processor (Calvin Co., Kansas City, Mo.). Longer life for magnetic heads is claimed when using the laminate, because the liquid tends to leave ridges at each edge that virtually saw into the head.

Striping equipment is available in a number of foreign countries. Pyral, of Paris, has added an electromagnetic thickness-measuring device for control of the thickness of the stripe while it is being applied.

In Germany, striping is done on 16-mm film for television recording and on 8-mm film for amateur use.

Eight Nation TV Network Begins

Britain, Belgium, Denmark, France, West Germany, Holland, Italy, Switzerland linked



WORLD-WIDE television network moved a step closer in June when tv viewers in eight European countries were able to tune in on the same programs simultaneously. A total of 18 programs will be exchanged during the four-week hookup. Estimates of the viewing audience for the first telecast ranged from 8 million to 20 million people.

▶ **Equipment**—The "Eurovision" network covers about 4,000 miles and utilizes 44 transmitters and more than 80 relay stations. Equipment used is largely British although each country involved has equipment of its own make in operation. U. S. equipment is represented mainly in cathode-ray tubes. It is estimated that $5 million in British equipment is in use.

▶ **How**—Many technical problems involved in converting the various standards used in the countries were solved when the coronation went out from London last year to France, Belgium, Holland, Western Germany and Berlin. However, that telecast was one-way only. On the present network two-way tv is possible over a large part of the network.

Converters are located in Breda, Holland, Paris and Dover to make the standards conversions necessary for the country involved. For example, for converting from French to British standards, an 819-line picture is displayed on a specially coated c-r tube and the scanning lines are broadened to eliminate line structure. The picture is then re-televised by a 405-line system camera.

▶ **Sales**—Foreign tv manufacturers as well as those in the U. S. are hoping that the international tv experiment will hypo sales of both sets and equipment in the countries involved. Manufacturers see a wide market, particularly for microwave equipment, for interstation links. The London radio show next fall is expected to emphasize the British electronics industry's ability to meet export demand for tv cameras, studio equipment, film scanners and outside broadcast units.

▶ **Future**—The present experimental network may become permanent. The nucleus of a permanent European network has been laid in the connections between Belgium, France and the Netherlands. Switzerland has established permanent links with Germany and Italy.

Phosphor Makers Face Good Business

Cathode-ray tubes represent a substantial market for the chemical coatings

TUBE manufacturers buy about 30,000 pounds of phosphor every month in picture-tube production, about 360,000 pounds a year. In dollars, this represents phosphor sales of $4.7 million annually. Each 21-inch tv picture tube needs about 8½ grams of phosphor, about 32 cents worth.

▶ **Uses**—Virtually all tv picture tubes contain the P4 phosphor with a blue-white phosphorescent color. Others of the most commonly used phosphors are: P1 for general oscilloscope use; P7, P12 and P14 for radar and sonar; P11 for photographic applications and P15 for flying-spot scanners.

A new phosphor, P23, has come on the scene for picture tubes but is not yet in widespread use. Developed by U. S. Radium Corp., it has persistence characteristics similar to those of P4 but the color is less blue.

▶ **Companies**—Ten manufacturers make phosphors for c-r tubes. Three of the leading producers are du Pont, Sylvania and U. S. Radium. Sylvania is apparently the only tube manufacturer in the phosphor business at the present time. Other cathode-ray tube manufacturers have attempted to move into the field of selling to outside companies but have not been successful. However, nearly all c-r tube manufacturers maintain phosphor laboratories that are working for better tv screens.

▶ **Color**—So far, color television has had little effect on the phosphor business. Volume is still small even though a color tube may use three times as much phosphor as black-and-white tv.

The present method of applying the dots is a three-step process in which the full face of the tube is coated three separate times with blue, red and green phosphors. The

(Continued on page 24)

For Optimum Reception

UNDER ANY CONDITIONS—

THE HAMMARLUND SUPER PRO-600

COMMUNICATIONS RECEIVER

Used by

MILITARY	AIRLINES
GOVERNMENT	MARINE
COMMERCIAL	AMATEUR

If reception is at all possible, the Super Pro-600 will bring in the signal. This professional communications receiver has gained world-wide recognition as the finest performing receiver available anywhere, regardless of price.

The Super Pro is now available, with or without fixed frequency control, in the following models:

STANDARD MODEL—for 540 Kc to 54 Mc

COMPLETELY JANized MODEL—for 540 Kc to 54 Mc

DIVERSITY MODEL—for use in dual or triple diversity terminals—540 Kc to 54 Mc

LONG-WAVE MODEL—10 Kc to 540 Kc

With the optional fixed frequency controls available on all models, operation on any of six crystal controlled frequency channels within the range of the receiver is immediately available at the flip of a switch.

For specifications and construction details, write for Bulletin S55.

SP-600-JX

Stability is .001 to .01 percent depending on frequency to which receiver is tuned; image rejection is 80 db to 120 db down, and spurious responses are at least 100 db down. Sensitivity is 1 microvolt CW and 2 microvolts AM, while selectivity for the three calibrated crystal and three non-crystal ranges is from 200 cycles to 13 Kc. Radiation is negligible with no cross-talk in multi-receiver installations. The power supply is an integral part of the receiver chassis.

The HQ-140-X is a modern superheterodyne receiver made to Hammarlund quality standards that provides commercial and amateur radio operators and short-wave listeners with all the advantages of modern professional design and circuitry.

For specifications and construction details, write for Bulletin 552.

HQ-140-X

Frequency coverage is continuously tunable from 540 Kc to 31 Mc (555 to 9.7 meters) in six bands. Its high selectivity makes possible the reading of a desired signal even when the band is extremely congested.

HAMMARLUND

THE HAMMARLUND MANUFACTURING COMPANY, INC.
Main Plant and Offices: 460 W. 34th ST., N. Y. 1, N. Y.
Midwest Sales Office: 605 N. Michigan, Chicago 11, Ill. • Export Sales Office: 13 E. 40th St., N. Y.

excess phosphor that is etched away to form the dots cannot be saved because of impurities it has picked up. Phosphor makers believe that improved methods of applying the phosphors may enable tube makers to use no more of it than is presently used for black-and-white tv.

Until that time comes, however, phosphor makers will enjoy tripled volume for every color tube produced. At present levels, color phosphor prices range from $12 to $27 per pound compared to $13.25 for white. As volume increases, phosphor makers expect color phosphors to decrease in price.

RETMA Organizes Automation Group

SUB-COMMITTEE to promote "standards for components for use in printed circuit assemblies compatible with automation requirements and with particular emphasis on revising existing types of components", was set up by RETMA at its Chicago meeting.

Membership is open to members and non-members of RETMA who are: Users of printed wiring or printed circuit assemblies; Producers of automatic electronic assembly equipment; Manufacturers of components but only through the chairman or a designated representative of their respective RETMA committee.

The first meeting of the group is scheduled for August 3 in New York City under the chairmanship of H. L. Shortt of Technograph Printed Electronics.

Industry Shorts

▶ **Retail** sales of tv receivers (see p 4) during the first four months of this year reached the highest volume on RETMA records, kept since 1951. April retail tv sales were also the highest recorded for the month.

▶ **End** of 1954 will see network color tv available in areas covering 95 percent of the tv homes in the country, according to NBC.

MEETINGS

SEPT. 30-OCT. 2, 1954: Second Annual International Sight and Sound Exposition, Palmer House Hotel, Chicago, Ill.

OCT. 4-6: National Electronics Conference, Hotel Sherman, Chicago.

OCT. 6-7: First Annual National Conference, IRE Professional Group on Nuclear Science, Sherman Hotel, Chicago, Ill.

OCT. 13-17: 1954 Annual Convention, Audio Engineering Society, Hotel New Yorker, New York, N. Y.

OCT. 14-17: Andio Fair, Hotel New Yorker, New York, N. Y.

OCT. 18-20: Radio Fall Meeting, Hotel Syracuse, Syracuse, N.Y.

OCT. 27-30: Thirtieth Annual Convention, National Association of Educational Broadcasters, Hotel Biltmore, New York, N. Y.

NOV. 4-5: East Coast Conference on Airborne and Navigational Electronics, IRE, Sheraton-Belvedere Hotel, Baltimore, Md.

NOV. 9: First International Automation Exposition, 242nd Coast Artillery Armory, New York, N. Y.

NOV. 10-11: Conference on Electronic Instrumentation and Nucleonics in Medicine, Morrison Hotel, Chicago, Ill.

NOV. 12-13: National Symposium on Quality Control Methods In Electronics, IRE and American Society for Quality Control, Hotel Statler, New York, N. Y.

NOV. 18-19: Sixth Annual Electronics Conference, Kansas City IRE, Hotel President, Kansas City, Mo.

JAN. 12-15, 1955: World Symposium on Applied Solar Energy, Stanford Research Institute, Westward Ho Hotel, Phoenix, Ariz.

JUNE 29-JULY 3: International Conference on Semiconductors, Netherlands Physical Society and UNESCO, Amsterdam, Netherlands.

JULY 6-9, 1954: International Conference on Electron Microscopy, Joint Commission on Electron Microscopy of International Council of Scientific Unions, London, England.

JULY 8-12: British IRE 1954 Convention, Christ Church, Oxford, England.

AUG. 10-13: Associated Police Communication Officers National Conference, William Penn Hotel, Pittsburgh, Pa.

AUG. 24-SEPT. 4: National Radio Show of Great Britain, Earls Court, London, England. ;

AUG. 25-27: 1954 Western Electronic Show & Convention, Los Angeles, Calif.

SEPT. 1-16: Golden Jubilee Meeting of the International Electrotechnical Commission, University of Pennsylvania, Philadelphia, Pa.

SEPT. 13-24: 1954: First International Instrument Congress And Exposition, Commercial Museum and Convention Hall, Philadelphia, Pa.

SEPT. 16-18: Joint Electron Tube Engineering Council, General Conference, Chalfonte-Haddon Hall, Atlantic City, N. J.

SEPT. 1954: International Scientific Radio Union, Amsterdam, Netherlands.

SEPT. 30-OCT. 1: Fifth Annual Meeting of the IRE Professional Group On Vehicular Communications, Rice Hotel, Houston, Texas.

▶ **Analog computer** center to be put into operation about July 1 at Princeton, N. J. by Electronic Associates, Inc. will provide analytical service on rental basis for industry and the military leading towards automation and improved design of industrial products.

▶ **Tightening** its requirements for amateur and commercial operators, FCC proposes to make ineligible members of Communist-dominated groups, consider the moral character of former Communists and convicted criminals and provide for submission of fingerprints.

▶ **BBC** has purchased two superturnstiles antennas for increased tv coverage for Scotland and Ireland.

▶ **Eight-Ounce** uhf power tetrode with 600-w plate dissipation has been developed by RCA for airborne radio transmitters.

▶ **Prediction** that more than 10 million color tv sets will be in use in U. S. homes by1959 was made by E. W. Engtrom of RCA.

▶ **First** leg of a 1,000-mile submarine cable communication system that follows the route of the Air Force missile test range in the Caribbean (ELECTRONICS, p. 8, Feb. 1954) has been completed by Western Electric. Sixteen carrier telephone repeater stations along the route provide amplification facilities for signals transmitted over the system's 12 channels.

MICROWAVE SIGNAL GENERATORS

Complete coverage of the range 950-10,800 mcs /sec.

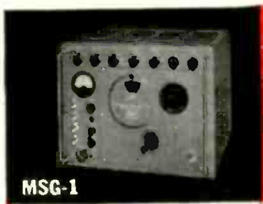
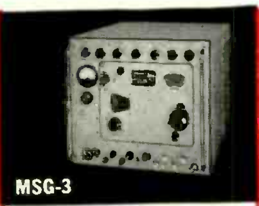
with Polarad single dial operation

Four new Microwave Signal Generators covering the range 950-10,800 mcs/sec. All with famous **Polarad single dial operation.** Each provides the maximum working range possible in one compact signal generator. And, additional Polarad Signal Generators are available to cover 12.8 to 39.7 kmc.

These features on all MSG units assure fast and simple operation: direct reading, single dial frequency control that tracks reflector voltages automatically . . . direct reading attenuator dial . . . conveniently placed controls, in logical sequence . . . high visibility on the face of each instrument.

Polarad Signal Generators are built to the same high standards required for military equipment. They are practical for the factory assembly line—engineered ventilation assures continuous and stable operation of all instrument functions. Components are readily accessible for easy maintenance. And laboratory accuracy is guaranteed under the most rigorous operating conditions.

Write directly to Polarad or your nearest Polarad representative for details.

	 MSG-1	MSG-2	 MSG-3	MSG-4*
Frequency Range	950-2400 MCS/sec.	2150-4600 MCS/sec.	4450-8000 MCS/sec.	6950-10,800 MCS/sec.
	(Frequency set by means of a single directly calibrated control)			
Frequency Accuracy	±1%	±1%	±1%	±1%
Power Output	1 MW	1 MW	.2 MW	.2 MW
Attenuator Range	120 db	120 db	120 db	120 db
Attenuator Accuracy	±2 db	±2 db	±2 db	±2 db
Output Impedance	50 ohms	50 ohms	50 ohms	50 ohms
Input Power	115V±10% 60 cps	115V±10% 60 cps	115V±10% 50-1000 cps	115V±10% 50-1000 cps
Internal Pulse Modulation:				
Pulse Width	0.5 to 10 microseconds			
Delay	3 to 300 microseconds			
Rate	40 to 4000 pulses per second			
Synchronization	Internal or external, sine wave or pulse			
Internal FM:				
Type	Linear sawtooth			
Rate	40 to 4000 cps			
Synchronization	Internal or external, sine wave or pulse			
Frequency Deviation	±2.5 MCS	±2.5 MCS	±6 MCS	±6 MCS
External Pulse Modulation:				
Polarity	Positive or Negative			
Rate	40 to 4000 pulses per second			
Pulse width	0.5 to 2500 microseconds			
Pulse separation	(For multiple pulses) 1 to 2500 microseconds			
Output Synchronizing Pulses:				
Polarity	Positive, delayed & undelayed			
Rate	40 to 4000 pps			
Voltage	Greater than 25 volts			
Rise time	Less than 1 microsecond			
Size | Approx. weight	17" long x 13¼" high x 15½" deep | 60 lbs.		17" long x 15" high x 19½" deep | 100 lbs.	

*Also available—MSG 4A: 6,950—11,500 MCS/sec.

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BROOKLYN 11, NEW YORK

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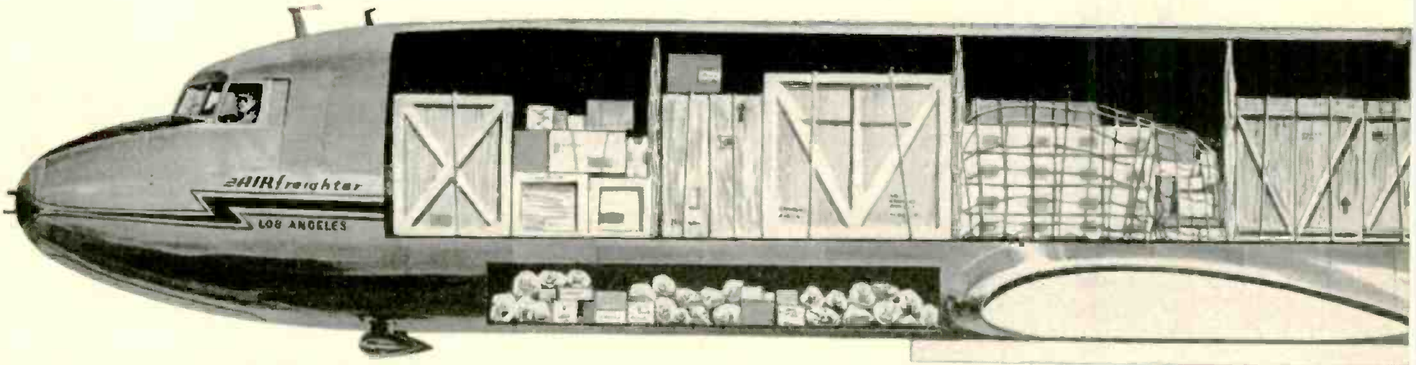
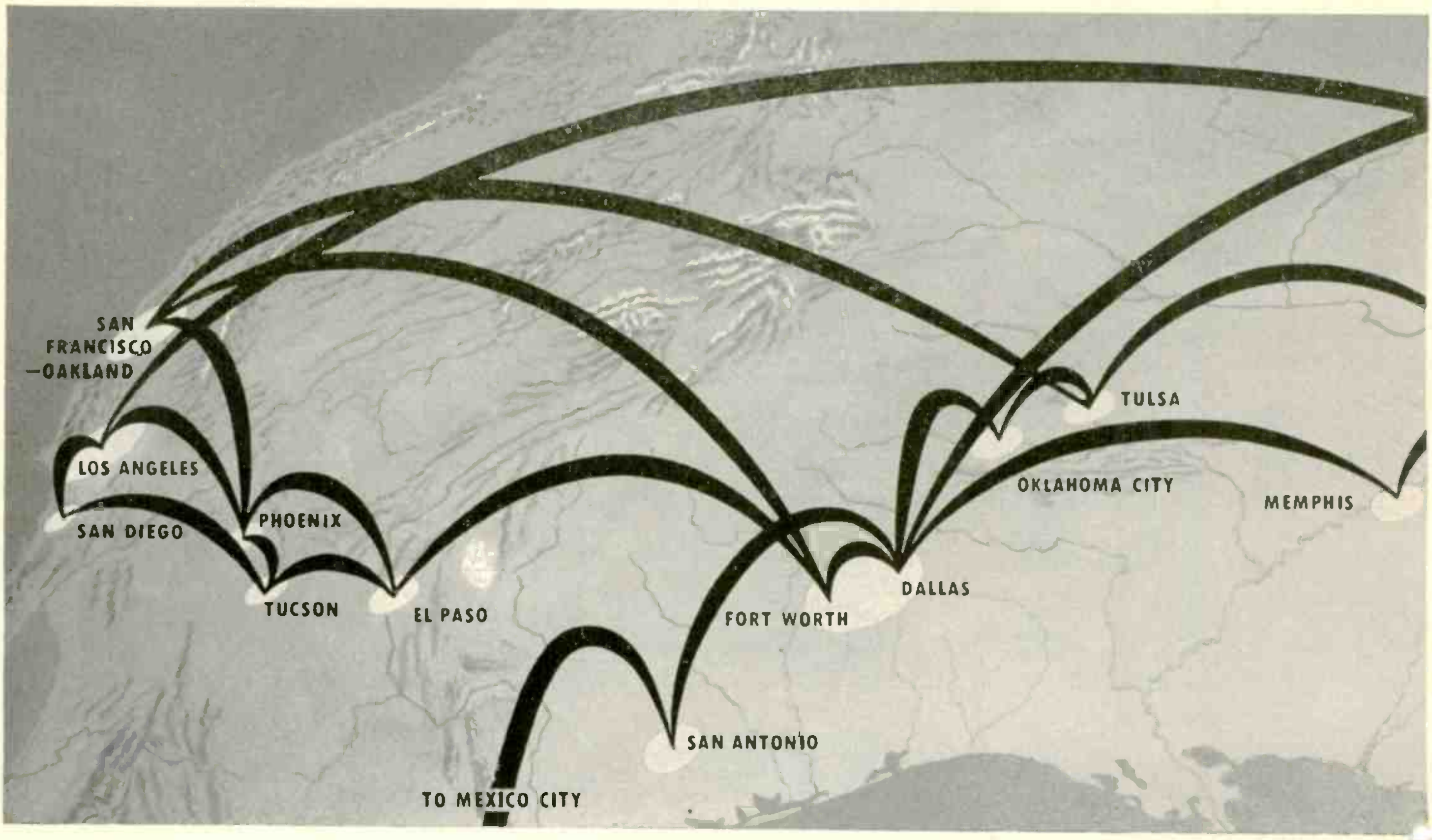
American Airlines has the greatest capacity in the
–more planes carrying freight to more places


AIRfreighter
LOS ANGELES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LOS ANGELES
SAN DIEGO
PHOENIX
TUCSON
EL PASO
FORT WORTH
DALLAS
SAN ANTONIO
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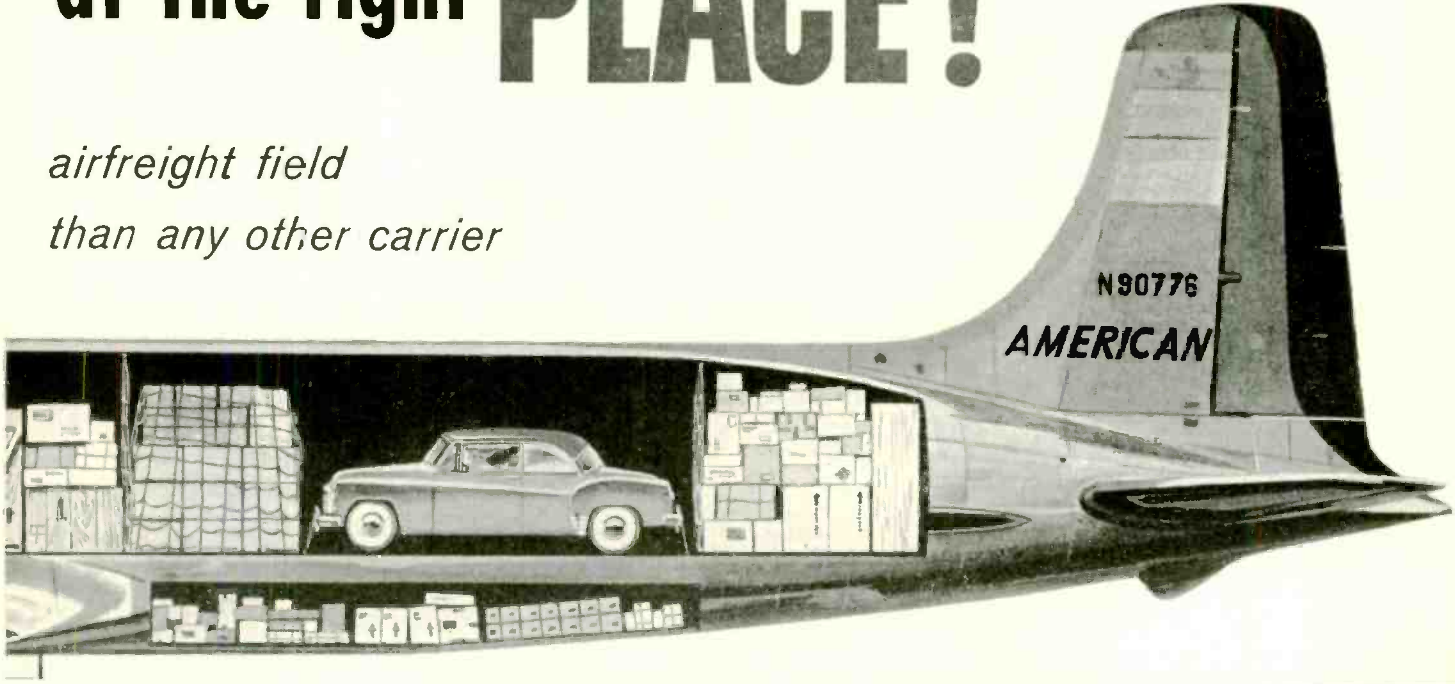
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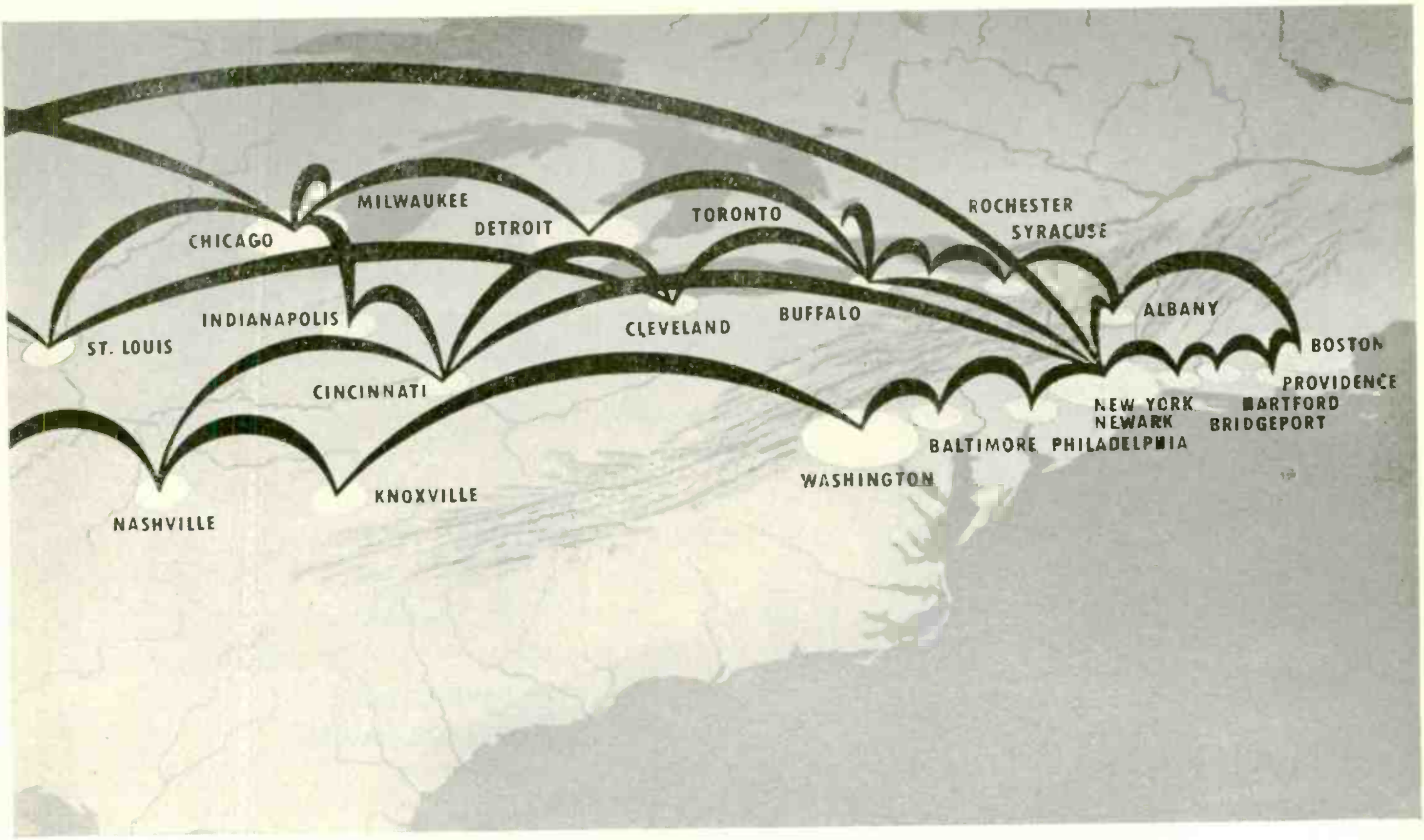
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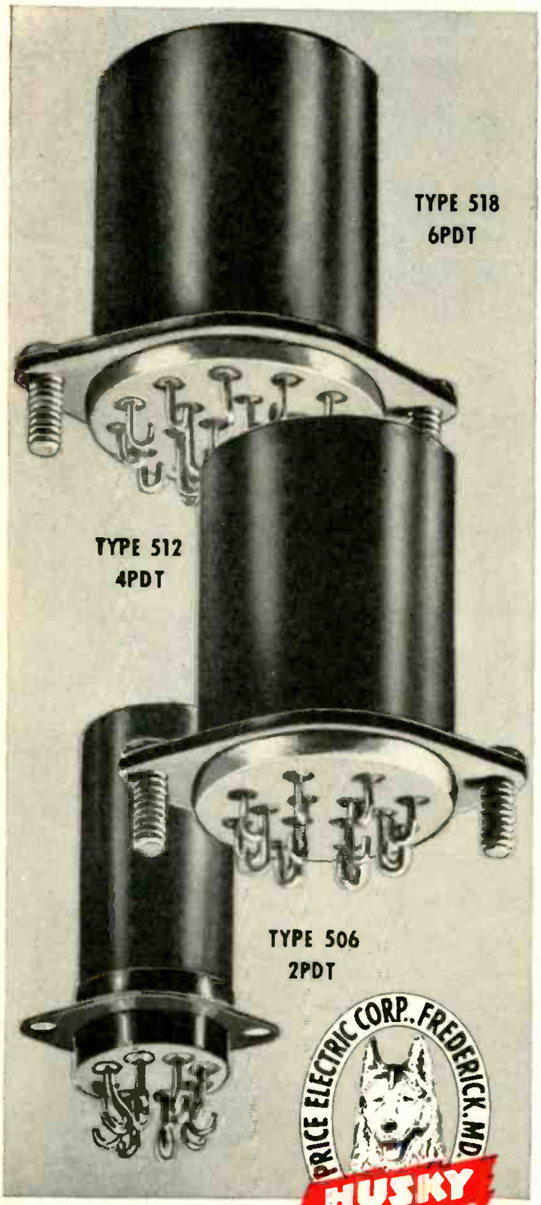
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506	1 21/32"	5/8"	7/8"
512	1 23/32"	1 3/64"	1 13/32"
518	1 23/32"	1 3/16"	1 9/16"

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CLASS C	— 65C to + 200C

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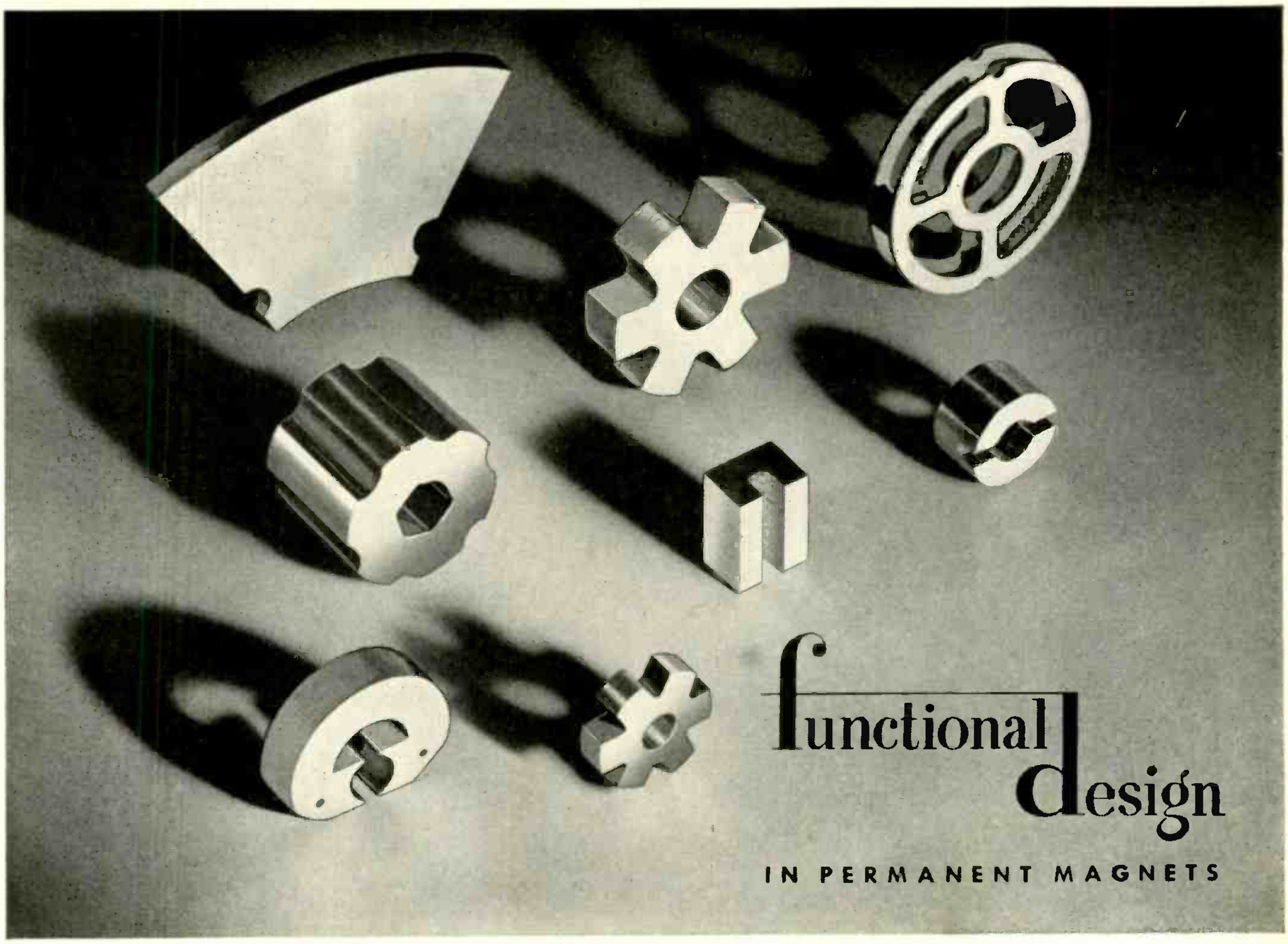
ONE IN A SERIES: discussing the importance of selecting the proper permanent magnet to use in your product



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GERMANIUM DIODE INTERCHANGEABILITY CHART

Type & Mfr.	G-E Replacement	Minimum Forward Cur. @ +1V. (MA)	Peak Inverse Voltage (Volts)	Cont. Reverse Voltage (Volts)	Maximum Reverse Cur. (μa)		Remarks
					@ −50V.	Other	
1A (TP)	None	60	5			100 @ −5V. 250 @ −15V.	Gold bonded diode
1B (TP)	None	30	15			100 @ −5V. 250 @ −15V.	Gold bonded diode
1C (TP)	None	30	15			100 @ −5V. 250 @ −15V.	Gold bonded diode
1D (TP)	G6		15 15				60% Rect. Eff. @ 100 Mc
1E (TP)	G7C		5 5				75% Rect. Eff. @ 100 Mc
1F (TP)	G7G		5 5				60% Rect. Eff. @ 100 Mc
1N34 (S,K,RR)	1N48	5.0 4.0	75 85	60 70	800 833	50 @ −10V.	
1N34A (S,A,RCA,RR,NU)	1N52	5.0 4.0	85	60 70	500 150	30 @ −10V.	
1N35 (S,K,Hy,RR)	G8A	7.5 4.0	75 85	50 70	150	10 @ −10V.	Matched pairs See Note 1
1N38 (S,K,RR,Hy)	1N70	3.0 3.0	120 125	100 100	300	6 @ −3V. 625 @ −100V. 25 @ −10V.	
1N38A (S,A,NU,Hy,RR)	1N63	4.0 4.0	125	100 100	50	6 @ −3V. 500 @ −100V.	
1N39A (Hy)	None	3.0	225	200		200 @ −100V. 800 @ −200V.	
1N39 (S,K)	1N75	1.5 2.5	225 125	200 100	50	200 @ −100V. 800 @ −200V.	
1N40 (S)	1N73	12.75 @ +1.5V. 15.0 @ +1.7V.	75 75	25		40 @ −10V. 50 @ −10V.	Quad, See Note 2 Quad, See Note 3
1N41 (S)	None						
1N42 (S)	1N73	12.75 @ +1.5V. 15.0 @ +1.7V.	120 75	50		6 @ −3V. 625 @ −100V. 50 @ −10V.	Quad, See Note 2 Quad, See Note 3
1N43 (WE)	1N69	5.0 5.0	60 75	60	850 850	20 @ −5V. 50 @ −10V.	
1N44 (WE)	1N70	3.0 3.0	115 125	100	1000 300	25 @ −10V.	
1N45 (WE)	1N65	3.0 2.5	75 85	70	410 200		
1N46 (WE)	1N48	3.0 4.0	60 85	70	1500 833		
1N47 (WE)	1N70	3.0 3.0	115 125	100	410 300	4 @ −3V. 25 @ −10V.	
1N48 (GE)		4.0	85	70	833		
1N51 (GE)		2.5	50	40	1667		
1N52 (GE)		4.0	85	70	150		
1N53 (M)	None						Silicon microwave diode
1N54 (S,K,Hy,RR)	1N69	5.0 5.0	75 75	35 60	850	10 @ −10V. 50 @ −10V.	
1N54A (S,A,NU,R,Hy,RR)	1N52	5.0 4.0	75 85	50 70	100 150	7 @ −10V.	
1N55 (S,K,RR,Hy)	1N75	3.0 2.5	170 125	150 100	50	300 @ −100V. 800 @ −150V.	
1N55A (NU,S,RR,Hy,RCA)	1N63	4.0 4.0	170 125	150 100	50	500 @ −150V.	
1N55B (H)	1N63	5.0 4.0	190 125	150 100	50	500 @ −150V.	
1N56 (S,K,Hy)	1N69	15.0 5.0	50 75	40 60	850	300 @ −30V. 50 @ −10V.	
1N56A (S,R,Hy,RCA)	1N69	15.0 5.0	50 75	40 60	850	300 @ −30V. 50 @ −10V.	
1N57 (S,K)	1N52	4.0 4.0	90 85	80 70	150	500 @ −75V.	
1N58 (S,K,RR,Hy)	1N63	4.0 4.0	120 125	100 100	50	800 @ −100V.	
1N58A (S,A,NU,RR,Hy,RCA)	1N63	4.0 4.0	120 125	100 100	50	600 @ −100V.	
1N60 (S,K,RR)	1N64	.05 @ +0.25V.	30 20	25		25 @ −1.3V.	See Note 4 See Note 5
1N61 (K)	1N63	5.0 4.0	140 125	130 100	50	300 @ −100V. 700 @ −125V.	
1N63 (GE)		4.0	125	100	50		
1N64 (GE)		.05 @ +0.25V.	20			25 @ −1.3V.	See Note 5
1N65 (GE)		2.5	85	70	200		
1N66 (R)	1N69	5.0 5.0	70 75	60 60	800 850	50 @ −10V. 50 @ −10V.	
1N67 (R)	1N63	4.0 4.0	100 125	80 100	50 50	5 @ −5V.	
1N67A (H)	1N63	4.0 4.0	100 125	80 100	50 50	5 @ −5V.	

Type & Mfr.	G-E Replacement	Minimum Forward Cur. @ +1V. (MA)	Peak Inverse Voltage (Volts)	Cont. Reverse Voltage (Volts)	Maximum Reverse Cur. (μa)		Remarks
					@ −50V.	Other	
1N37A (N)	None	3.0	40	36		.06 @ −20V.	Silicon junc. diode
1N138A (N)	None	5.0	20	18		.01 @ −10V.	Silicon junc. diode
1N139 (GE)		20.0	50	40	1500		Gold bonded diode
1N140 (GE)		40.0	85	70	300		Gold bonded diode
1N141 (GE)		20.0	85	70	50		Gold bonded diode
1N142 (GE)		5.0	125	100		100 @ −100V.	Gold bonded diode
1N143 (GE)		40.0	125	100		100 @ −100V.	Gold bonded diode
1N147 (L)	G7A	10.0 @ 0.75V. 0.8 @ +0.5V.	2 5			800 @ −0.5V	UHF mixer See Note 6
1N148 (Hy)	G7E	0.26 @ 0.25V. 0.8 @ +0.5V.	20 5	15		350 @ −10V. 800 @ −0.5V.	Harmonic generator diode
1N150 (M)	None						Silicon microwave diode
1N151 (GE)		1570 @ +0.7V.	100	30		2400 @ −100V.	
1N152 (GE)		1570 @ +0.7V.	200	65		1900 @ −200V.	
1N153 (GE)		1570 @ +0.7V.	300	100		1200 @ −300V.	
1N155 (S)	None						Silicon microwave crystal
1N155A (S)	None						Silicon microwave crystal
1N158 (GE)		1570 @ +1.4V.	380	185		800 @ −380V.	
1N160 (M)	None						Silicon microwave diode
1N175 (NU)	None	20.0		200	50	200 @ −200V.	Small-area diode
1N191 (H)	None	5.0		90	125 (55° C.)	25 @ −10V. (55° C.)	Computer type
1N192 (H)	None	5.0		70	250 (55° C.)	50 @ −10V. (55° C.)	Computer type
1N193 (S)	None	1.0 @ +2.0V.		40 (150° C.)		50 @ −40V.	Silicon whisker diode
1N194 (S)	None	1.5 @ +2.0V.		40 (150° C.)		60 @ −40V.	Silicon whisker diode
1N195 (S)	None	2.0 @ +2.0V.		40 (150° C.)		80 @ −40V.	Silicon whisker diode
1N196 (S)	None	1.0 @ +2.0V.		40 (150° C.)		40 @ −40V.	Silicon whisker diode
600 (T)	1N81	3.0 3.0	30 50	40		1 @ −1V. 8 @ −10V. 10 @ −10V.	Silicon Junction diode
601 (T)	None	3.0	50			.01 @ −1V. .04 @ −40V.	Silicon Junction diode
CG2-E (BTH)	None	1.0	150		2.5		
CG5-E (BTH)	None	2.8	40			0.2 @ −10V.	
CG6-E (BTH)	1N65	2.0 2.5	70 85	70	200	50 @ −10V	
CG8-C (BTH)	None	4.0	15			1.5 @ −3V. 2.0 @ −10V.	
CG10-E (BTH)	1N65	2.0 2.5	100 85	70	250 200	50 @ −10V.	
CG12-E (BTH)	1N64	3.0 .05 @ +0.25V.	25 20			400 @ −10V. 25 @ −1.3V.	
CK705 (R)							Same as 1N66
CK705A (R)	1N69	5.0 5.0	70 75	60 60	800 850	10 @ −10V. 50 @ −10V.	
CK705-P (R)	1N69	5.0 5.0	70 75	60 60	800 850	50 @ −10V. 50 @ −10V.	
CK706-P (R)	1N64	0.05 @ +0.25V.	50 20	40		200 @ −10V. 25 @ −1.3V.	See Note 5
CK706 (R)	1N64	.05 @ +0.25V.	50 20	40		200 @ −10V. 25 @ −1.3V.	See Note 7 See Note 5
CK707 (R)	1N52	3.5 4.0	100 85	80 70	100 150	10 @ −5V.	
CK707-P (R)	1N52	3.5 4.0	100 85	80 70	100 150	10 @ −5V.	
CK708 (R)							Same as 1N68
CK708-P (R)	1N75	3.0 2.5	120 125	100 100	50	625 @ −100V.	
CK709 (R)	1N73	15.0 @ +1.7V.	75			50 @ −10V.	Quad, See Note 8 Quad, See Note 3
CK710 (R)	G7A	3 @ +0.5V.	10	5		200 @ −.6V.	See Note 9 See Note 6
CK711 (R)	1N73	15 @ +1.7V.	75	80	30	50 @ −10V.	Quad, See Note 10 Quad, See Note 3
CK712 (R)	1N75	2.0 2.5	225 125	200 100	50	800 @ −200V.	
CK713 (R)	1N52	21 @ +2.0V. 4.0	75 85	75 70	150	250 @ −40V.	
CK713A (R)	1N52	21.0 @ +2.0V. 4.0	85 85	70 70	150	250 @ −40V.	
CK713A-P (R)	1N52	21.0 @ +2.0V. 4.0	85 85	70 70	150	250 @ −40V.	
CK715 (R)	G7E	0.8 @ +.5V.	5	40		800 @ −.5V.	Frequency Mult. Frequency Mult.
CK715-P (R)	G7E	0.8 @ +0.5V.	5	40		800 @ −0.5V.	Frequency Mult. Frequency Mult.

1N67P (R)	1N63	4.0 4 0	100 125	80 100	50 50	5 @ 5V.	
1N68A (H)	1N75	3 0 2 5	130 125	100 100	50	625 @ – 100V.	
1N68 (R)	1N75	3 0 2 5	120 125	100 100	50	625 @ – 100V.	
1N69 (GE)		5 0	75	60	850	50 @ – 10V.	JAN type
1N70 (GE)		3.0	125	100	300	25 @ – 10V.	JAN type
1N71 (S,Hy)	None						Quad
1N72 (GE)		0.8 @ +.5V.	5			800 @ – 5V.	See Note 6
1N73 (GE)		15.0 @ +1.7V.	75			50 @ – 10V.	Quad. See Note 3
1N74 (GE)		15.0 @ +1.8V.	75			50 @ – 10V.	Quad. See Note 3
1N75 (GE)		2 5	125	100	50		
1N76							Silicon diode
1N77	None						Photo diode
1N78 (M)	None						Silicon diode
1N79 (S)	None						Silicon diode
1N81 (GE)		3.0	50	40		10 @ – 10V	JAN type
1N82 (S,Hy)	G7A	0.8 @ +.5V.				800 @ – 5V	UHF Mixer See Note 6
1N82A (S)	G7A	0.8 @ +0.5V.		5		800 @ –0 5V	Silicon UHF Mixer diode. See Note 6
1N86 (A)	1N48	4.0 4 0	85 85	70 70	833 833	50 @ – 10V.	
1N87 (A)	1N64	.05 @ +0.25V.	30 20	25		25 @ – 1.3V.	See Note 11 See Note 5
1N88 (A)	1N52	2.5 4.0	100 85	85 70	100 150		
1N89 (H)	1N52	3.5 4.0	100 85	80 70	100 150	8 @ – 5V.	
1N90 (H)	1N69	5 0 5.0	75 75	60 60	800 850	50 @ – 10V.	
1N91 (GE)		470 @ +0.5V.	100	30		2700 @ – 100V.	Diffused Junction Rectifiers
1N92 (GE)		310 @ +0.5V.	200	65		1900 @ – 200V.	
1N93 (GE)		250 @ +0.5V.	300	100		1200 @ – 300V.	
1N94 (GE)		1570 @ +0.7V.	380	185		800 @ – 380V.	
1N95 (H)		10 0 5.0	75 75	60 60	800 850	50 @ – 10V	
1N96 (H)	None	20 0	75	60	800		
1N97 (H)	None	10.0	100	80	100	8 @ – 5V	
1N98 (H)	None	20 0	100	80	100	8 @ – 5V.	
1N99 (H)	None	10.0	100	80	50	5 @ – 5V.	
1N100 (H)	None	20 0	100	80	50	5 @ – 5V.	
1N106 (NU)	None	20 0		300		70 @ – 100V 200 @ – 300V.	Gold bonded
1N107 (NU)	None	150 0		10		200 @ – 10V.	Gold bonded
1N108 (NU)	None	50.0		50		200 @ – 50V	Gold bonded
1N109 (Hy)	G7E	0.26 @ 0 25V 0 8 @ +0 5V	20 5	15		350 @ – 10V. 800 @ –0.5V.	Harmonic generator diode
1N110 (RR)	G7A	0 8 @ + 5V				800 @ – .5V	See Note 12 See Note 6
1N111 (S,RR,Hy)	1N52	5.0 4 0	70 85	70	125 150	25 @ – 10V.	Computer type
1N112 (S,RR,Hy)	1N52	5 0 4 0	70 85	70	250 150	50 @ – 10V.	Computer type
1N113 (S,RR,Hy)	1N52	2.5 4 0	70 85	70	125 150	25 @ – 10V.	Computer type
1N114 (S,RR,Hy)	1N65	2 5 2 5	70 85	70	250 250	50 @ – 10V.	Computer type
1N115 (S,RR,Hy)	1N65	2 5 2 5	70 85	70	500 250	100 @ – 10V.	Computer type
1N116 (H)	1N52	5 0 4 0	75 85	60 70	100 150		
1N117 (H)	None	10 0	75	60	100		
1N118 (H)	None	20 0	75	60	100		
1N124 (L)	1N72	10 @ +0 75V. 0 8 @ +0 5V	2 5			800 @ –0 5V.	UHF mixer See Note 6
1N124A (L)	1N72	10 @ +0 75V. 0 8 @ +0 5V				800 @ –0.5V.	UHF mixer See Note 6
1N125 (Hy)	1N64	.05 @ +0 25V 05 @ +0 25V	30 20			25 @ – 1 3V 25 @ – 1 3V	See Note 5
1N126 (H)	1N69	5 0 5 0	75 75	60 60	850 850	50 @ – 10V. 50 @ – 10V.	JAN type JAN type
1N127 (H)	1N70	3 0 3 0	125 125	100 100	300 300	25 @ – 10V. 25 @ – 10V	JAN type JAN type
1N128 (H)	1N81	3 0 3 0	50 50	40 40		10 @ – 10V 10 @ – 10V	JAN type JAN type
1N133 (Hy)	G7A	3 0 @ +0 5V 0.8 @ +0 5V	6 5			300 @ –0 6V 800 @ –0 5V.	UHF mixer See Note 6
1N135 (Hy)	1N69	5 0 5 0	75 75	60	850 850	50 @ – 10V 50 @ – 10V	
CK731 (R)	1N72	0.8 @ +0.5V.	5			800 @ –0.5V.	See Note 6
CK739 (R)	None	100 @ +0.8V.	60	50	20	2 @ – 10V.	Gold bonded diode
CK742 (R)	None	100 @ +1.0V.	125	100		5 @ – 10V. 20 @ – 100V.	Gold bonded diode
CV425 (BTH)	1N48	4.0 4 0	65 85	70	1000 833		
CV442 (BTH)	1N64	3.0 05 @ +0.25V.	25 20			1000 @ – 10V. 25 @ – 1.3V.	
CV448 (BTH)	1N52	3.0 4 0	80 85	70	100 150		
G1CA (IRC)	1N75	1.0 2.5	125 125	100	50 50		
G1HA (IRC)	1N65	1.0 2.5	85 85	70	500 250		
HS133 (Hy)	G7A	0.8 @ +0.5V.	5	5		800 @ –0.5V.	UHF Silicon Mixer diode. See Note 6
NU34 (NU)	1N69	5.0 5.0	75 75	65 60	800 850	50 @ – 10V. 50 @ – 10V.	
NU38 (NU)	1N70	3.0 9 5	120 125	100 100	300	6 @ – 3V. 625 @ – 100V. 25 @ – 10V.	
NU39 (NU)	None	1.5	225	200		200 @ – 100V. 800 @ – 200V.	
NU58 (NU)	1N63	4.0 4 0	120 125	100 100	50	800 @ – 100V.	
S4 (TR)	None	1.0	50	40		1 @ – 10V.	Silicon diode
S5 (TR)	None	1 0	50	40		0.1 @ – 10V.	Silicon diode
S6 (TR)	None	4 0	22	20		0.5 @ – 5V.	Silicon diode
T1 (TR)	1N139	20.0 20 0	50 50	40 40	1500 1500		Gold bonded diode Gold bonded diode
T2 (TR)	1N140	40.0 40.0	85 85	70 70	300 300		Gold bonded diode Gold bonded diode
T3 (TR)	1N141	20.0 20.0	85 85	70 70	50 50		Gold bonded diode Gold bonded diode
T4 (TR)	1N142	5.0 5.0	125 125	100 100		100 @ – 100V. 100 @ – 100V.	Gold bonded diode Gold bonded diode
T5 (TR)	1N143	40.0 40.0	125 125	100 100		100 @ – 100V. 100 @ – 100V.	Gold bonded diode Gold bonded diode
TP34A(TP)	1N52	5.0 4.0	75 85	60 70	500 150	30 @ – 10V.	
TP38A (TP)	1N63	4.0 4.0	120 125	100	50	5 @ – 3V 500 @ – 100V.	
TP39 (TP)	None	1.5	225	200		200 @ – 100V. 800 @ – 200V.	
TP52 (TP)	1N52	4.0 4.0	85 85	70 70	150 150		
TP55 (TP)	1N75	3 0 2 5	170 125	150 100	50	300 @ – 100V. 800 @ – 150V	
TP55A (TP)	1N63	4 0 4 0	170 125	150 100	50	500 @ – 150V	
TP63 (TP)	1N63	4 0 4 0	125 125	100 100	50 50		
X-16 (TP)	G7E	0.8 @ +0.5V.	5			800 @ –0 5V	Harmonic generator

Note 1: Forward resistances matched within 10% at +1V.

Note 2: Four diodes in tube shell with forward resistances balanced within +2.5% at +1 5V. Forward resistances of each pair matched within 3 ohms.

Note 3: Four diodes in hermetically sealed tube shell. Forward resistances matched within 6.7 ohms for 1N73 and 13.4 ohms for 1N74 at 15 MA. Forward resistances of each pair matched within 2 ohms for 1N73 and 6.7 ohms for 1N74 at 15 Ma

Note 4: Tested with 1.8V. RMS input at 40 Mc, 70% modulated at 400 cycles. Minimum output is 1.8V. peak-to-peak across 4700 ohms shunted by 5 MMF.

Note 5: Tested with 0.1V. RMS, 44 Mc input to last I.F. grid. Minimum output is 100 ua through 3600 ohms shunted by 5 MMFD.

Note 6: Maximum conversion loss is 9.6 db measured at 900 Mc with 0.7 Mw L.O. level and d-c forward bias from a 0 25V., 250 ohm source.

Note 7: Tested with 0.1V. RMS, 50 Mc input to last I.F. grd. Minimum output is 330 ua through 5100 ohms shunted by 5 MMFD

Note 8: Four diodes in tube shell with forward resistances matched within 2.5%. At - 10V diodes are matched 2 5% or all have a resistance greater than 1.0 meg ohm.

Note 9: Typical noise temperature ratio of 2.

Note 10: Four diodes in tube shell. Each pair of diodes is shunted by 10,000 ohms center-tapped and the center tap of resistor and diodes connected by a microanimeter. With 0 to +3V. dc applied unbalance current limit is 5 MA

Note 11: Tested with 5V. peak input at 30 Mc. Output voltage across 3900 ohm load resistance must yield minimum rectification efficiency of 60%.

Note 12: Noise figure 12 db @ 750 Mc with 43.5 Mc I.F. circuit having 3 Mc noise bandwidth and 4 db noise figure.

*For additional information, contact General Electric Company, Electronics Park, Syracuse, New York, or your nearest G-E Tube Representative

For additional information, contact General Electric Company, Electronics Park
Syracuse, New York, or your nearest G-E Representative.

A—Amperex
G—Federated Semi-conductor
GE—General Electric
H—Hughes
Hy—Hytron
K—Kemptron
M—Microwave Associates
N—National Semi-conductor Products
NU—National Union
RR—Radio Receptor
R—Raytheon
RCA—RCA
S—Sylvania
T—Texas Instruments
TR—Transitron
TP—Transistor Products

- General Electric is the only company that manufactures a full line of Germanium products: gold bonded, hermetically sealed, welded and power diodes, transistors, rectifiers . . . more than 80 separate types. No matter what your electronic or electrical circuitry design problem is, call on G. E. first.

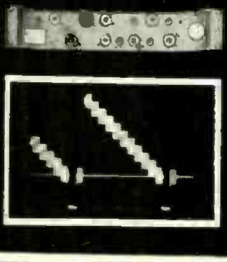
For detailed information on any of these G-E products or a free file copy of the above chart, write: *General Electric Company, Section X474, Electronics Park, Syracuse, N. Y.*

GENERAL ELECTRIC

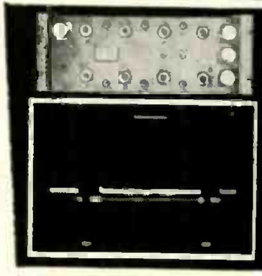
TELECHROME
INCORPORATED

NEW

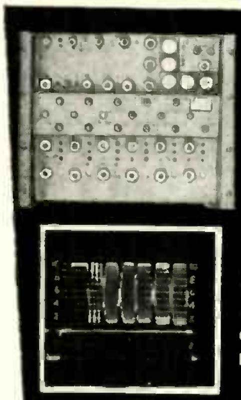
VIDEO
TRANSMISSION TEST EQUIPMENT



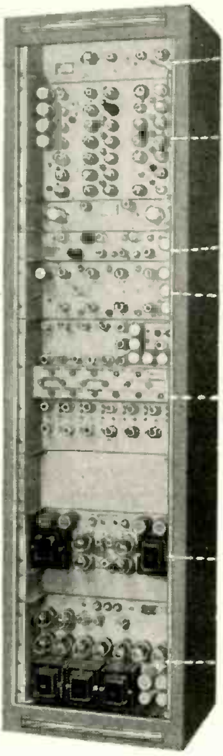
1041-BR STAIR STEP GENERATOR (Variable) Checks lineary and grey scale output relationship in linear or non-linear system. Built-in color carrier generator may be added to steps. Back porch burst allows lock-in to 3.58 MC color equipment.



1071-AR WINDOW GENERATOR (Variable) Determines ringing, smears, steps, low frequency tilt, phase shift, mismatched terminations; etc. In TV signals or systems.

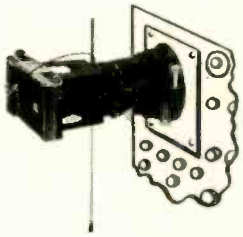


1070-BR MULTI-BURST FREQUENCY GENERATOR (13 freq. selectable from .5 to 6 MC) Checks wide band coaxial cables, microwave links, individual units, and complete TV systems for frequency response characteristics. Produces six frequencies simultaneously plus white bar reference. Switchable color burst on back porch.


AUTOMATIC FREQUENCY CONTROL 304AR
COMPOSITE SYNCH GENERATOR 303BR
STAIR-STEP GENERATOR
WINDOW GENERATOR
MULTI-BURST FREQUENCY GENERATOR
REGULATED POWER SUPPLY 512AR
REGULATED POWER SUPPLY 613BR

New Telechrome equipment designed to provide test signals for precise checking of video facilities.

This equipment is now in use by major networks, TV stations, and the Bell Telephone System. This type of equipment was recently described by H. Gronberg of NBC before the NARTB Engineering Conference in Chicago. These units are available individually or as an integrated system with 75 ohm or 110 ohm balance output.



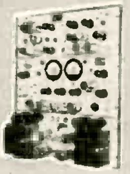
OSCILLOSCOPE CAMERA

MODEL 1521-AR (Polaroid Land Type)

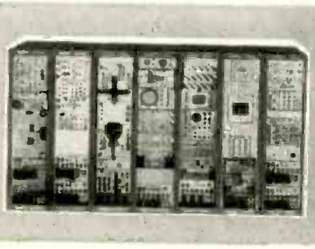
for instantaneous 1-to-1 ratio photo-recording of these test signals.

Chromalyzer

Chromoscope (Signal Certification)



Phase Slope (Envelope Delay) Curve Tracer



Full facilities Transmits, receives, monitors, analyzes composite color pictures

Literature on these and more than 100 additional instruments for color TV by TELECHROME are available on request.

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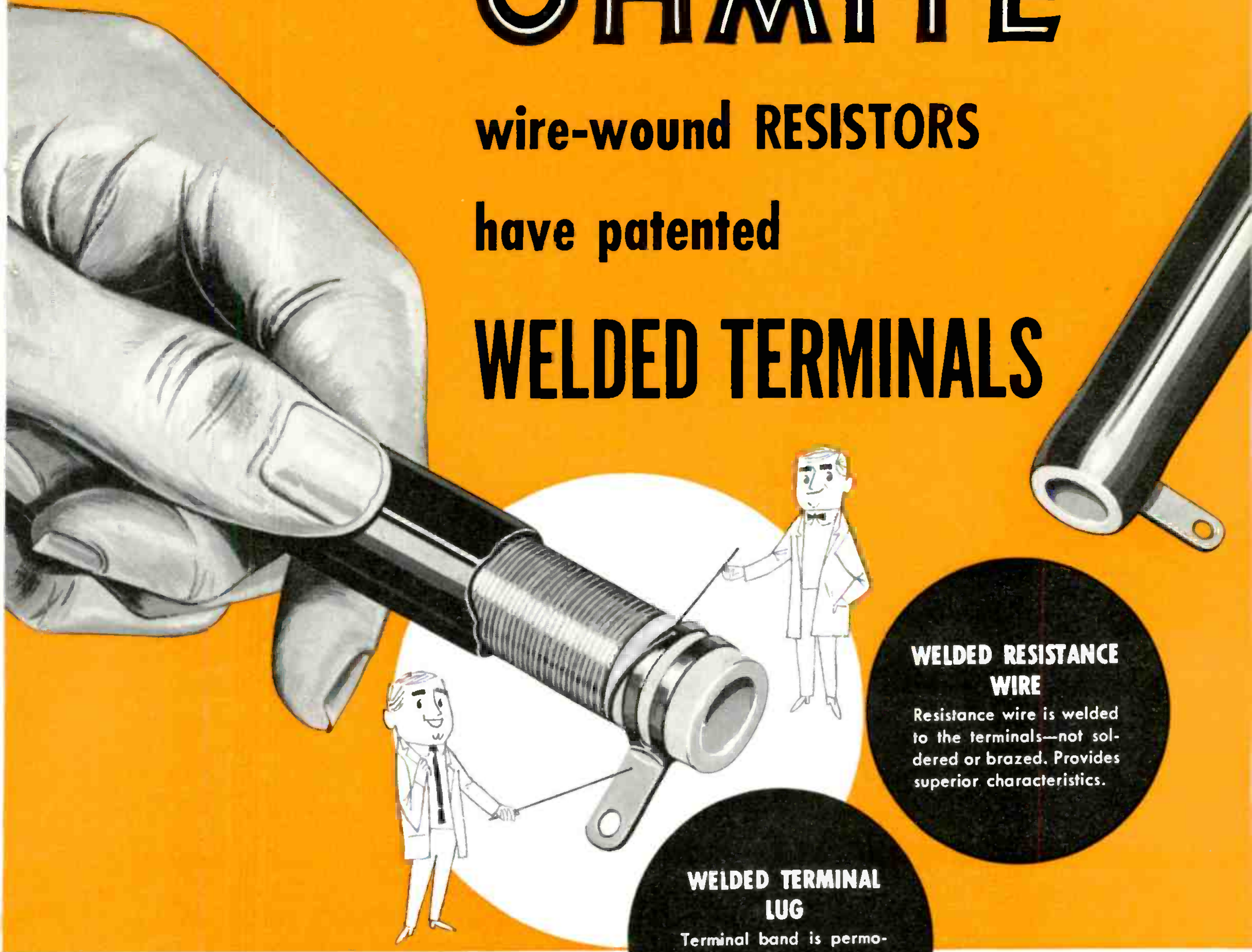
OHMITE®

wire-wound RESISTORS have patented WELDED TERMINALS



WELDED RESISTANCE WIRE

Resistance wire is welded to the terminals—not soldered or brazed. Provides superior characteristics.

WELDED TERMINAL LUG

Terminal band is permanently and securely held around the resistor tube by welding.

PATENTED WELDING PROCESS

Assures permanent terminal connections, unaffected by vibration or high temperatures.

STABLE ELECTRICAL CONNECTIONS

Extremely important in eliminating noise in audio circuits or instability in other highly sensitive circuits.

HIGH-STRENGTH ALLOY TERMINALS

High strength and properly related expansion coefficients keep terminals firmly anchored and prevent cracking of the enamel.

PROVED IN YEARS OF SERVICE

For more than ten years, millions of these resistors have proved their reliability under the toughest service.

Ohmite resistors provide other important advantages, too—a superior vitreous-enamel covering, which holds the windings rigidly in place, preventing "hot spots" and protecting the winding from moisture and fumes; strong ceramic core that is unaffected by cold, heat, fumes, or high humidity; and hot tinned terminal lugs for ease in soldering. For unfailing dependability, specify Ohmite resistors.

OHMITE

MANUFACTURING COMPANY

3610 Howard Street, Skokie, Ill.
(Suburb of Chicago)

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OHMITE® offers an unusually complete line of

MIL TYPE RHEOSTATS AND RESISTORS

The ONLY COMPLETE LINE

MIL-R-22A
RHEOSTATS

Ohmite can furnish rheostats to meet MIL-R-22A requirements in each of the 26 type designations. These severe requirements again prove the dependability of Ohmite rheostats. All-ceramic construction, close control, and smooth operation insure years of trouble-free service. It will pay you to standardize on Ohmite rheostats.

MIL-R-26B
wire-wound
RESISTORS

Ohmite offers an unusually complete line of tab-terminal, ferrule-terminal, axial-terminal tubular resistors, and tab-terminal, flat type resistors that meet the most rigid requirements (char. "G," "J," and "F") of MIL-R-26B. Ohmite offers 33 of the 38 resistor styles listed in MIL-R-26B, in a complete range of resistance values.

OHMITE®

FIRST IN RESISTANCE PRODUCTS

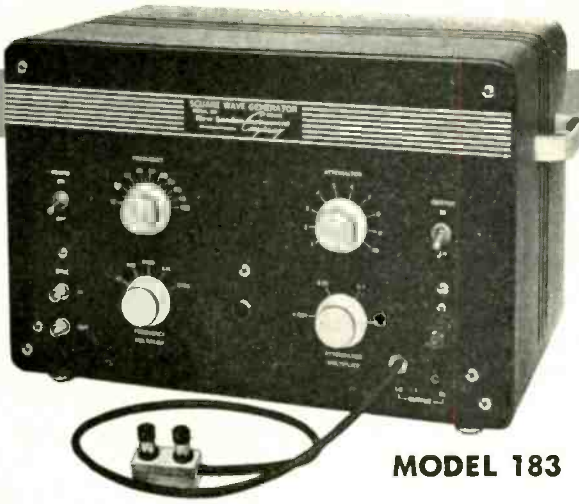
OHMITE MANUFACTURING COMPANY, 3610 Howard Street, Skokie, Illinois (Suburb of Chicago)

QUALITY PRECISION INSTRUMENTATION

SQUARE WAVE GENERATOR

Combines Voltage Calibrator and Source of Square Waves

This high-quality precision instrument provides square waves suitable for testing the transient and frequency response of wide band amplifiers and accurately measures their amplitude. Provides a wide range of output levels. Attenuator settings do not affect the output wave shape. Frequency range: 10 cps to 1 Mc continuously variable over decade steps. Rise time is 0.02 μsec.

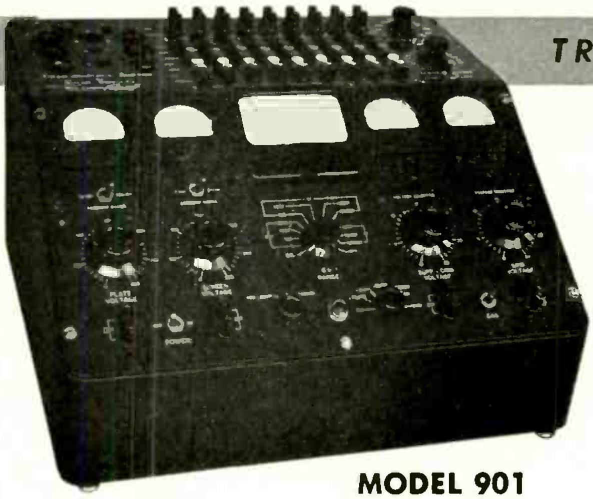


MODEL 183

TRANSCONDUCTANCE ANALYZER

AND CIRCUIT SIMULATOR

New, Simplified Tube Analyzer



MODEL 901

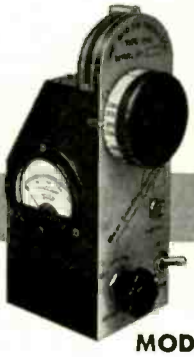
This direct-reading vacuum tube transconductance meter measures transconductance under all operating conditions. It also reproduces all kinds of static or dynamic tube characteristics.

It can be connected externally to components to simulate the circuitry in which the tube will operate. Simple push button switching applies the appropriate voltages to each tube element. Self-contained — no accessories required.

BROADBAND AMPLIFIER

MODEL 160

Uniform Response from
15KC — 50MC
60 db gain



MODEL 200

UHF GRID DIP OSCILLATOR

Versatile — Compact — Lightweight
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MODULATION MONITOR

MODEL 252

Wide Range — Low Distortion
(100-225 MC or 225-400 MC)

Write for specifications and catalog on our complete line of measuring equipment.

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Are you ready for a major electronic and electrical first—Magnetics, Inc. "Performance-Guaranteed" Shields for shielding of standard cathode ray and other tubes against moderate and high flux external fields . . . and custom-designed "Performance-Guaranteed" Shields for specific shielding problems?

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FREE ENGINEERING DESIGN . . . Our Engineering Department will carry out all phases of your shield design . . . including magnetic analysis . . . mechanical design . . . and production engineering to your cost requirements.

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Over 300 different jobs go through our plant every day. This volume allows us to apply mass production techniques to every job—whether simple or complex, long run or short—*and we pass the savings on to you.*

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We will prove to you that your sheet metal requirements in aluminum or steel can be *individualized and yet be low in cost.* We will prove to you that our complete "package" service will lower your costs. Send us samples, sketch or prints and a prompt quotation will follow.

Television

✳ See examples of Karp craftsmanship at the WESCON SHOW, Los Angeles, Calif., August 25th to 27th, 1954, Booths 618-619.

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Division of H & B American Machine Company
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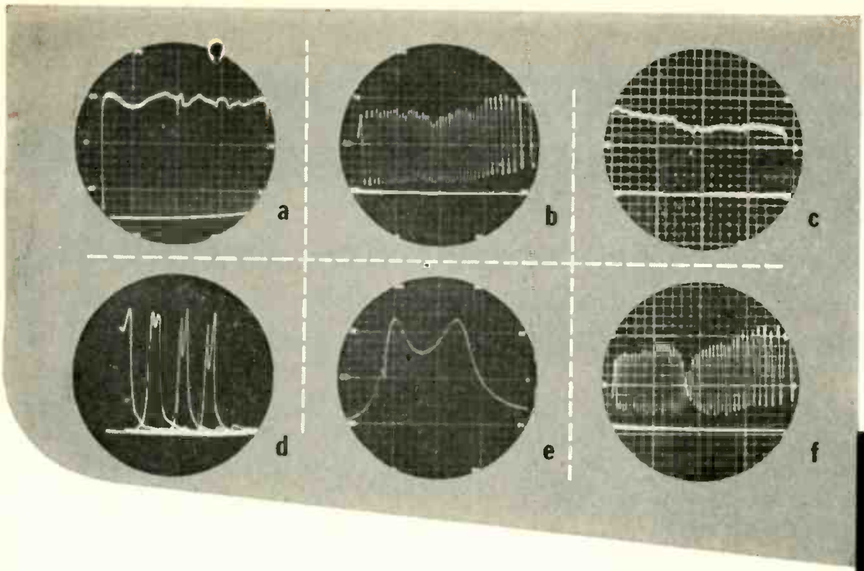

470 to 890 MC. CHARACTERISTICS TAKEN WITH 2144-02 GENERATOR

- a) Detected output of sweep generator, showing marker at 650 mcs.
- b) VSWR display of unterminated transmission line.
- c) VSWR display of terminated transmission line.
- d) Preselector responses of UHF tuner at channels 14, 20, 30 and 40.
- e) Preselector response of tuner at channel 50, expanded on scope.
- f) Input VSWR display of tuner at channel 50.

now sweep over 400 mc. at UHF without tuning

New Kollsman TYPE 2144 Wide Range Sweep Generator

SPECIFICATIONS

Frequency Range	2144-01	225 to 420 mc.
	2144-02	470 to 890 mc.
	2144-03	850 to 1275 mc.
Minimum Power Output		10 milliwatts
Output Impedance		50 ohms
Maximum Source VSWR		1.25
Amplitude Linearity		± 1 db.
Marker Frequency Calibration		5 mc.
Marker Frequency Accuracy	2144-01	± 1 mc.
	2144-02	± 1.5 mc.
	2144-03	± 2 mc.
Sweep Rate		60 cycle
Tube Complement		6AF4, 6J6, OA2, 6X4
Primary Power		117 volts, 60 cycles, 60 watts

3 Stock models cover 225 to 420 mc. 470 to 890 mc. and 850 to 1275 mc. Special ranges on request.

Also Available—Step Attenuator TYPE 2171-01

SPECIFICATIONS

Insertion Loss	Less than ½ db.
Attenuation Steps	0, 3, 6, 9, 12, 15, 20, 30, 40, 50, 60, 70, db.
Frequency Range	DC to 1000 mc.
Maximum VSWR	1.2

Other Attenuation Steps Available

THE TYPE 2144 SWEEP GENERATOR SIMPLIFIES LABORATORY AND PRODUCTION MEASUREMENTS

- Instantaneous display of frequency response, impedance or VSWR over 400 mc. without test equipment adjustment.
- Simultaneous observation of desired and spurious receiver responses.
- Display antenna characteristics over entire operating band.

WITH THESE DESIRABLE FEATURES

- 50 ohm output.
- Low source VSWR and amplitude non linearity.
- Passive variable marker for stable, accurate frequency indication, with easily read dial.
- Oscilloscope horizontal sweep signal and base line retrace blanking.
- 60 cycle sweep rate for easy observation.
- Voltage regulation minimizes effect of line voltage variation.
- Uses only standard plug in tubes.

Write FOR COMPLETE INFORMATION ON KOLLSMAN TYPE 2144 SWEEP GENERATORS AND TYPE 2171 ATTENUATORS.

kollsman INSTRUMENT CORP.

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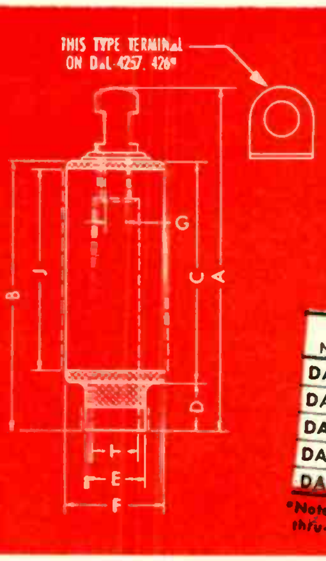
*Conforms to the requirements of Grade L-5A in accordance with JAN-1-10.

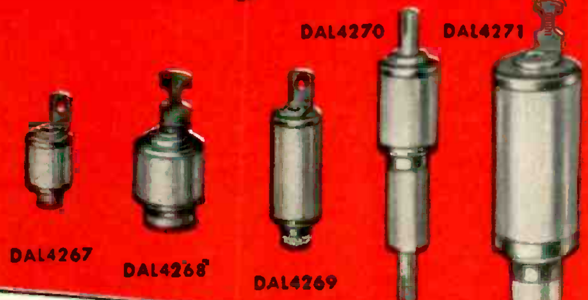
SOLDERSEAL HERMETIC TERMINALS

THE ITEMS SHOWN ARE STANDARD STOCK TERMINALS. DIMENSIONAL TOLERANCE, ±1½% BUT NOT LESS THAN ±.010"

featuring

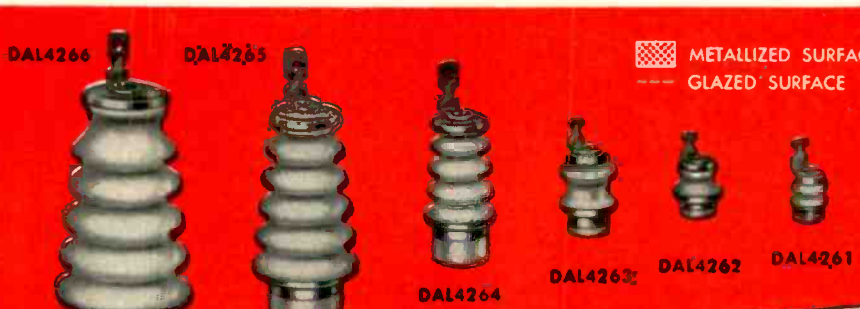
- High Mechanical Strength
- Resistance to Thermal Shock
- Fast, Easy Installation
- Permanent Hermetic Sealing



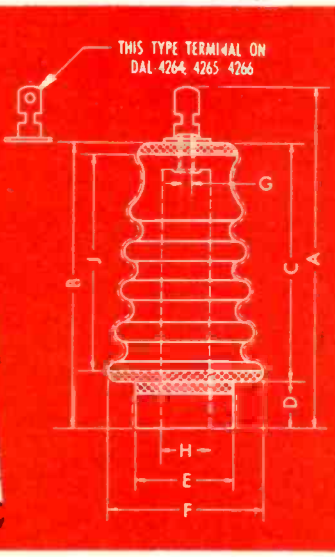


PART NUMBER	VOLTS RMS†	A	B	C	D	E	F	G	H	J
		DIMENSIONS								
DAL4267	4000	.547	.375	.281	.093	.125	.234	.046	.084	.250
DAL4268	5000	.687	.422	.312	.109	.250	.359	.049	.171	.281
DAL4269	8000	.875	.687	.562	.125	.156	.250	.046	.093	.531
DAL4270*	10000	1.187	.937	.437	.500	.234	.312	–	–	.375
DAL4271	15000	1.531	1.250	.937	.312	.281	.453	.090	.187	.781

*Note: Part No. DAL4270 employs solid thru-stud slotted at each end.



▨ METALLIZED SURFACE
--- GLAZED SURFACE



PART NUMBER	VOLTS RMS†	A	B	C	D	E	F	G	H	J
		DIMENSIONS								
DAL4261	3000	.672	.391	.282	.109	.250	.312	.067	–	.171
DAL4262	4000	.750	.468	.312	.156	.312	.437	.067	–	.160
DAL4263	7000	.968	.687	.500	.187	.375	.500	.095	.156	.375
DAL4264	14000	1.343	1.250	.907	.343	.490	.625	.128	.250	.812
DAL4265	18000	2.218	1.750	1.407	.343	.656	.937	.118	.312	1.250
DAL4266	22000	2.655	2.187	1.844	.343	.812	1.187	.128	.375	1.643

†40% Relative Humidity

These terminals are made of glazed Alumina Ceramic. Lugs and eyelets are hot tinned brass and metallized areas are silver fired on ceramic, copper electroplated and tin fused for soft soldering. Immersion in 60/40 solder at 450°F for 1½ minutes for dip soldering will not injure the metallic coating. For complete information and quotations call, write or wire today.

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VALLEY 6-5100

GENERAL OFFICES and PLANT: KEASBEY, NEW JERSEY

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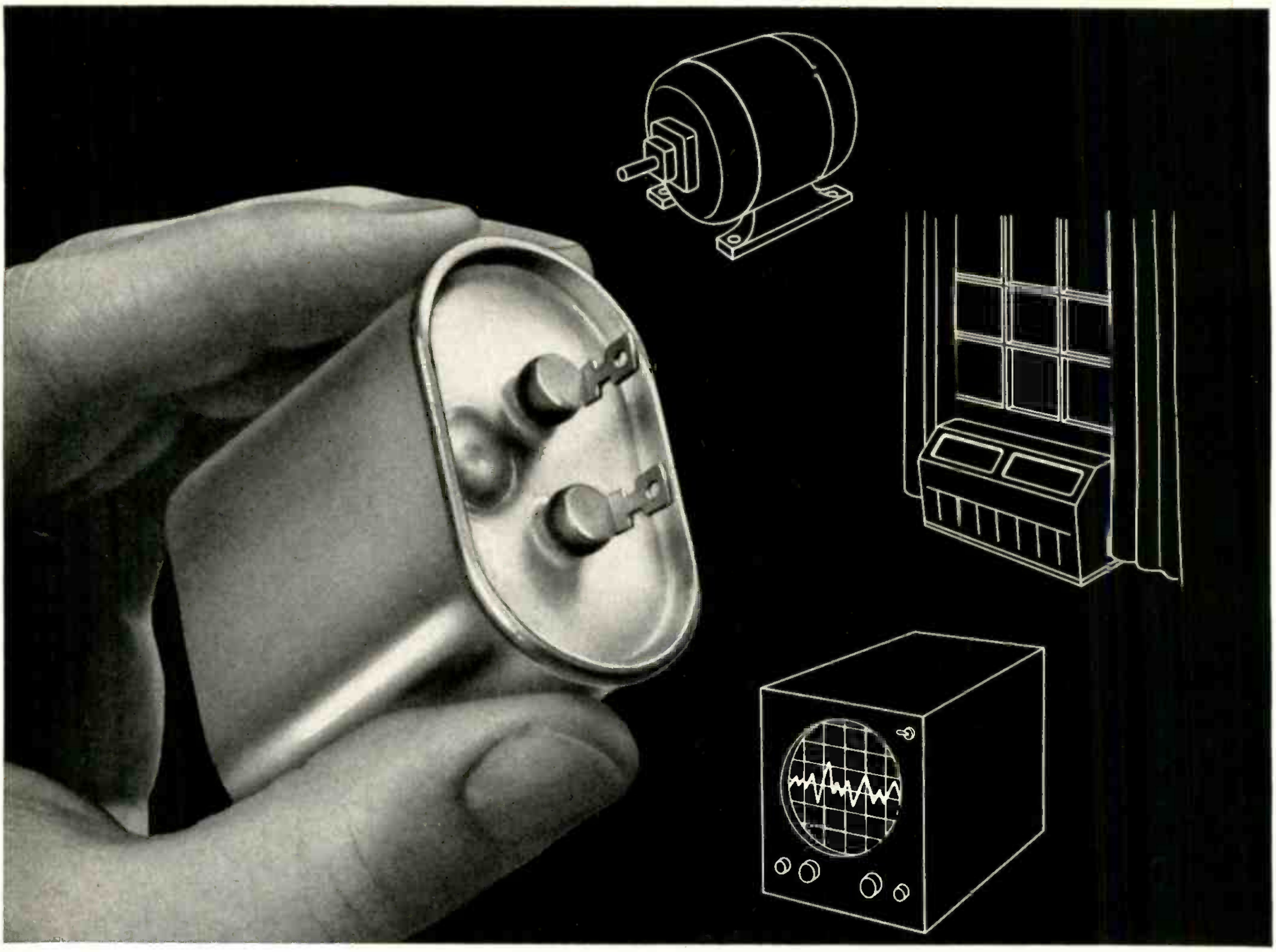


Save space and weight in electronic equipment with versatile G-E drawn-oval capacitors

LONG RELIABILITY. G-E drawn-oval fixed paper-dielectric capacitors have been manufactured for fluorescent lamp ballasts and air-conditioning equipment for ten years. They also offer the important advantages of smaller size, lighter weight, and substantial cost reductions to the electronics industry. So, if you're using a fixed paper-dielectric capacitor in your electronic equipment consider the advantages offered by G-E drawn-ovals.

WIDE RANGE OF RATINGS. Ratings range from 1 to 15 uf at 600 to 1500 volts dc, or 330 to 660 volts ac. A wide choice of mounting arrangements makes G-E drawn-ovals ideally suited for quality electronic equipment, controls, and other applications where capacitors meeting the electrical and mechanical requirements of MIL-C-25A specifications (except for case dimensions and markings) are desirable.

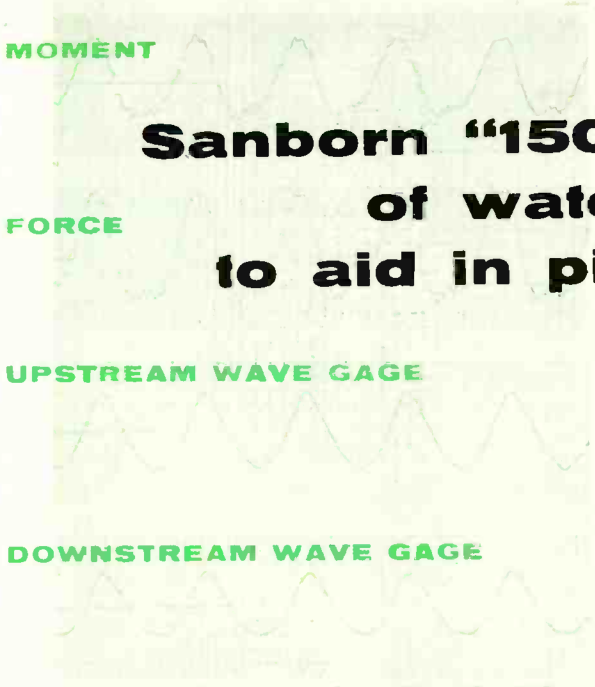
UP TO 20% COST REDUCTION. Prices range from 10 to 20% below those for similarly rated rectangular capacitors. Savings in size and weight amount to as much as 30% in some case styles. A double rolled seam attaches cover to drawn steel case, producing a lighter, yet stronger, capacitor.

CHOICE OF MOUNTINGS AND TERMINALS. Mounting versatility is provided by a choice of three bracket styles for upright, inverted, or side mounting to suit individual application requirements. Units are also available with either eyelet (pictured above), fork type, or quick-connect (solderless) terminals.

For more information on G-E drawn-oval capacitors, their ratings, dimensions, and prices, contact your G-E apparatus sales representative or write for Bulletin GEA-5777, to General Electric Co., Section 442-10, Schenectady 5, N. Y.

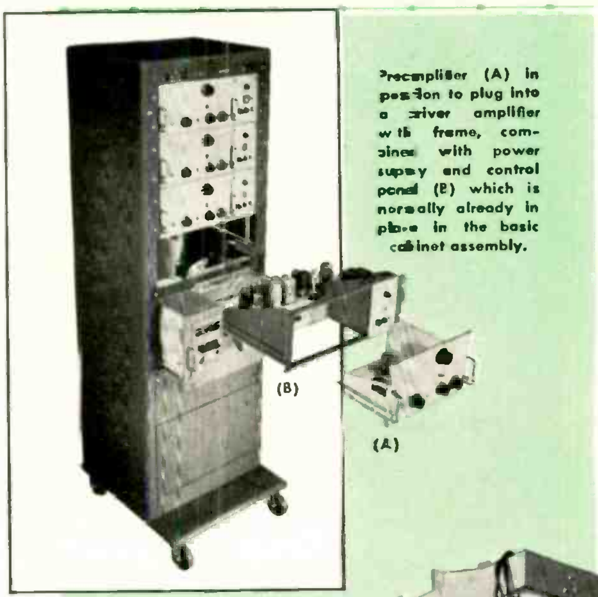
Progress Is Our Most Important Product

GENERAL ELECTRIC



Sanborn "150" records the effects of water wave forces to aid in pile structure design

By means of a Sanborn 150 Oscillographic Recording System equipped with four carrier type preamplifiers, engineers at the M.I.T. Hydrodynamics Laboratory are getting accurate pictures of simulated shallow water waves and their effect on dummy piles. The shape and length of precisely controlled waves in a 90 foot glass flume are plotted simultaneously with their moment and force on a suspended cylindrical pile. The excellent frequency response available with this method permits a sensitivity and accuracy not obtainable in previous model studies of this type.



Preamplifier (A) in position to plug into a driver amplifier with frame, combined with power supply and control panel (B) which is normally already in place in the basic cabinet assembly.

This is but one of MANY applications possible with Sanborn 150 Oscillographic Recording Systems

Virtually all electrical phenomena, within a frequency range of zero to 100 cps, can be accurately, permanently and graphically registered by Sanborn Oscillographic Recording Systems. This versatility of application is possible because of the *flexibility* of Sanborn 150 Series Recording Systems. A wide variety of quickly *interchangeable* preamplifiers, which plug in to *built-in* driver amplifiers (illustrated at left), are available for use with Series 150 Systems, to record such phenomena as: stress, strain, pressure, displacement, thickness, velocity, acceleration, current, voltage, temperature, torque, light, flow, force, load, position, rpm, radiation, tension, and power.

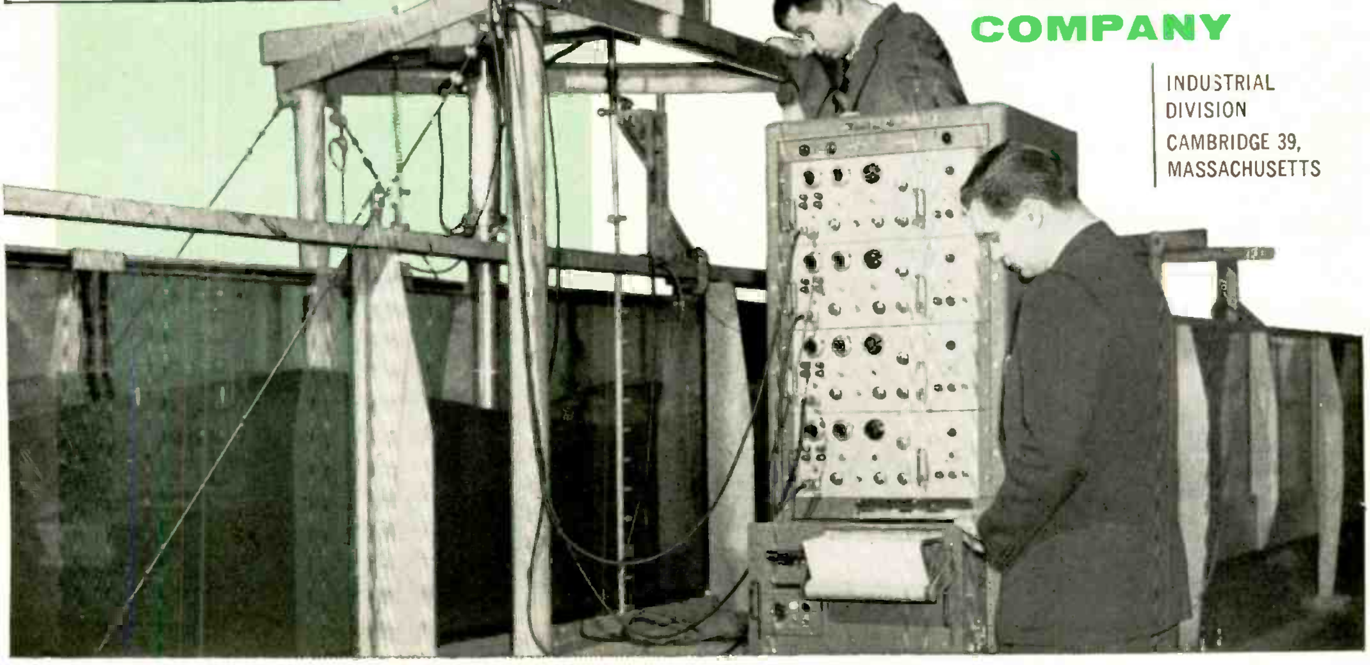
Add to this versatility the Sanborn features of inkless tracings in true rectangular coordinates, on plastic coated chart paper . . . high torque movement . . . time and code markers . . . numerous chart speeds.

Let Sanborn Answer YOUR Recording Requirements

For informative technical data on the basic 1, 2, and 4 channel Sanborn systems, and qualified counsel to help you select the correct Sanborn equipment for your requirements, write to

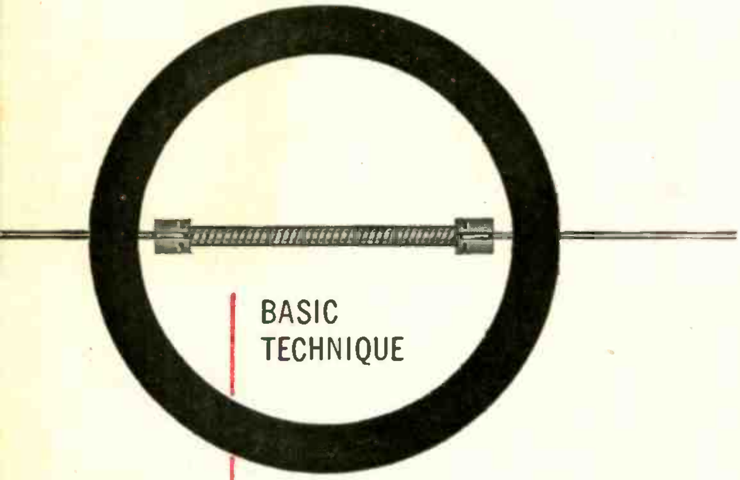
SANBORN COMPANY

INDUSTRIAL DIVISION
CAMBRIDGE 39, MASSACHUSETTS



Precision, high-speed winding equipment for IRC elements

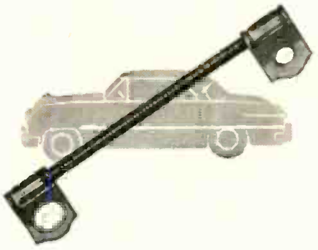
ONLY IRC WINDING SKILL OFFERS



BASIC TECHNIQUE

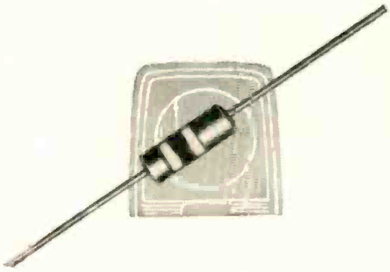
Wire element is uniformly and tightly wound on an insulated core. Axial leads or other terminations are secured to element by automatic machinery. Insulated housing may be used or omitted.

If you seek savings in component costs,
IRC's winding skill may serve your need.
IRC's mastery of winding wire elements
dates back more than 25 years. Today,
it provides a wide variety of unique units
that offer realistic possibilities for
savings. Cost-conscious IRC engineers
will glady analyze your requirements.



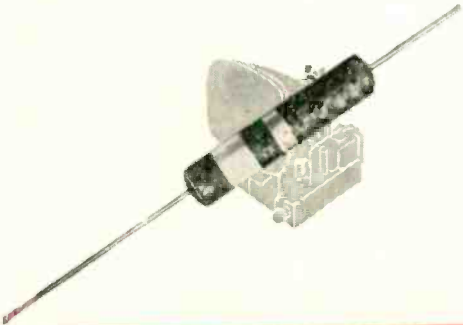
14c savings per car

Type AW Wire Wound resistors save automobile manufacturers an average of 14c per car. For quantity requirements, these low-cost windings can be made specially to suit individual designs. This adaptability has proved profitable to numerous appliance manufacturers.



low cost—low wattage

Type BW insulated wire wounds offer excellent stability in low ranges—at low prices. Leading instrument manufacturers attest to their superiority. ½, 1 and 2 watt sizes are equivalent to Jan types RU-3, RU-4 and RU-6.



50% savings

IRC Insulated Chokes offer savings up to 50% over ordinary types. Available in two sizes, they are fully protected against humidity, abrasion, assembly damage and danger of shorting to chassis. A favorite source of savings for TV and radio set manufacturers.

THESE SAVINGS

IRC
PW 4 WATT

inexpensive solution

4-watt Insulated Power Wire Wounds with axial leads can save several cents over conventional power resistors. Inorganic core and high-temperature plastic housing allow safe operation up to 165° C. Widely used in toys, juke boxes and amusement devices.

NEW
specifications

IRC
PRECISION
WIRE WOUND
RESISTOR

MIL-R-93A
AMENDMENT 1

Government specifications for precision wire wound resistors have been revised. MIL-R-93A Amendment 1 is the new rigid standard.

IRC PRECISION
WIRE WOUNDS

meet and beat these new specifications. They are equivalent to Mil types RB-15 through 19.

MAXIMUM STABILITY

Temperature cycling even beyond Mil requirements has only negligible effect. Send for new technical bulletin.

Boron & Deposited Carbon Precistors • Power Resistors • Voltmeter Multipliers • Low Wattage Wire Wounds • Insulated Composition Resistors • Volume Controls •

Wherever the Circuit Says

IRC

Precision Wire Wounds • Ultra HF and Hi-Voltage Resistors • Low Value Capacitors • Selenium Rectifiers • Insulated Chokes • Hermetic Sealing Terminals •

INTERNATIONAL RESISTANCE CO.
403 N. Broad St., Philadelphia 8, Pa.
In Canada: International Resistance Co., Ltd., Toronto, Licensee

Send me technical data on: ☐ Precision Wire Wounds; ☐ Insulated Chokes; ☐ BW Resistors; ☐ 4-Watt Power Resistors

Name______________________________

Title______________________________

Company___________________________

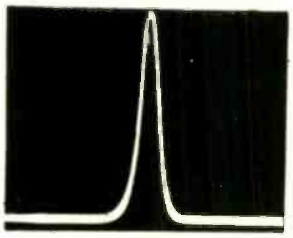
Address___________________________

City__________________State__________

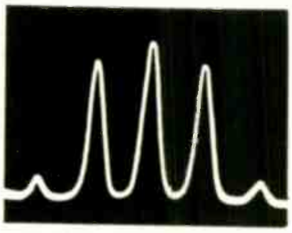
F.M. DEVIATION DIRECTLY MEASURED

THE BESSEL ZERO or " Disappearing Carrier " method of measuring deviation requires complex monitoring equipment, an accurately known modulation frequency, and, finally, mathematical interpretation of results.

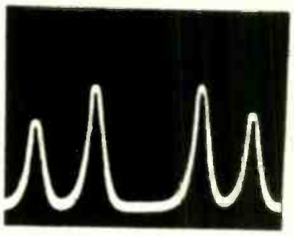
With the compact and easy-to-use Marconi Deviation Meter, the modulation frequency need not be known and deviation is directly read on a meter scale.



Unmodulated Carrier



Modulation Index 1.3



Modulation Index 2.4
The Carrier "Disappears"
BESSEL ZERO METHOD

F. M. DEVIATION METER TYPE TF 934

Carrier Frequency Range: 2.5 to 200 megacycles.
R.F. Input Level: 55 millivolts to 10 volts.
Deviation Measurement Ranges: 0 to ±5 kc, 0 to ±25 kc and 0 to ±75 kc.
Accuracy of Deviation Measurement: ±3% from full-scale to half-scale up to 12 kc and ±6% up to 15 kc.

Full data and prices of any of the items listed below will be mailed immediately on request:

F.M. DEVIATION METER TF 934 · UNIVERSAL BRIDGE TF 868
FM/AM SIGNAL GENERATOR TF 995A · STANDARD SIGNAL GENERATOR TF 867
Also
VACUUM TUBE VOLTMETERS · FREQUENCY STANDARDS · OUTPUT METERS
WAVEMETERS · WAVE ANALYSERS · Q METERS · BEAT FREQUENCY OSCILLATORS

MARCONI INSTRUMENTS

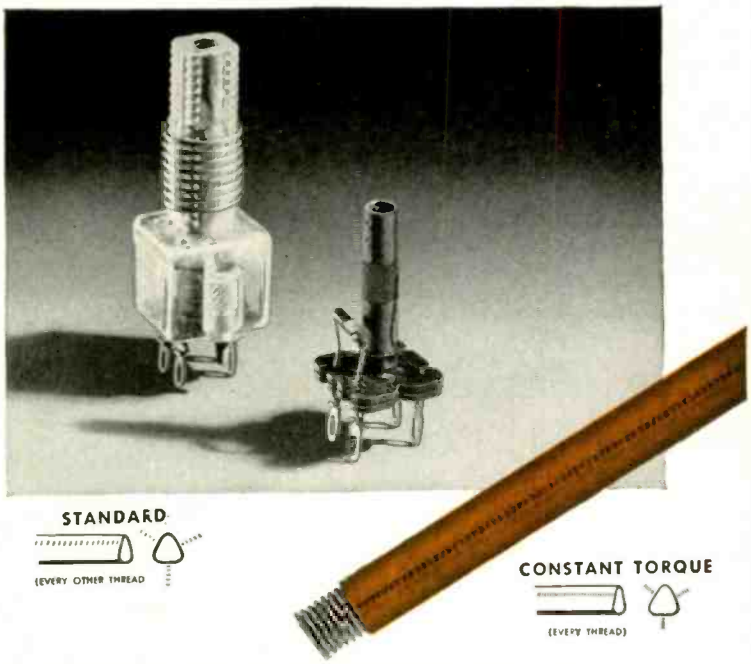
23-25 BEAVER STREET · NEW YORK 4
CANADA: CANADIAN MARCONI CO., MARCONI BUILDING, 2442 TRENTON AVENUE, MONTREAL
ENGLAND: Head Office: MARCONI INSTRUMENTS LIMITED, ST. ALBANS, HERTFORDSHIRE
Managing Agents in Export: MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, MARCONI HOUSE, STRAND, LONDON, W.C.2

TC40

C-D-F SPIRAL TUBING

A UNIFORM, HIGH QUALITY PRODUCT AT LOW COST

Good dielectric strength • Low dielectric loss properties
Good mechanical strength and moisture resistance



C-D-F is a dependable source of supply for all of your coil form spiral tubing needs. Uniform, high product quality is maintained by rigid standards of manufacture. C-D-F offers you fabricating skill, backed by exacting technical and inspection control. A recent C-D-F development is Grade 5 Constant Torque Tubing for use in coil forms. After the threaded iron tuning core is inserted and finally adjusted, you obtain the same stable torque rating.

Constant Torque features: exact internal threading . . . every thread engaged. 3-point contact with core prevents binding and permits positive tuning and re-tuning. Outer surface of tube has no weak spots, no external embossing to cause cement leakage. Available in lengths up to 14″ to take .248″ to .250″ core with 28 threads per inch and also 6-32, 8-32 and 10-32 screw sizes. Write for samples.

Grade 5 Tubing is also custom-fabricated by C-D-F in conventional shapes to accommodate other sizes of tuning cores.

C-D-F produces spiral tubing in grades to meet most requirements. Use the Grade Selector Chart when requesting samples and additional information.

AVAILABLE GRADES

IMPREGNATED

1 General Electrical and Mechanical Grade. ○
1A Electrical and Mechanical Grade—Special Punching. ○
2 Mild Stapling, Riveting, and Post Forming Quality. ○
2A Intermediate Fabricating and Stapling Quality. ○
3 Severe Stapling, Riveting, and Post Forming Quality. ○
5 Constant Torque and Formed-to-Shape Coil Form Tubing. △ ⍋
6 Special for High Humidity Applications. ○
6A Extra Hard, High Strength Tubing. ○
7 Soft Varnished Kraft Tubing. ○ □ ▭
7A Hard, Rigid Rectangular Tubing. □ ▭
8 Varnished Diamond Insulation—Tubing. ○
9 "Deflection Coil" Tubing. ○
10 Larger Size, Heavy Wall Tubing for Mechanical Uses. ○

UNIMPREGNATED

20 Special Wound in Specified Combinations of kraft paper, fish paper, etc. ○ □ ▭
21 Plain Kraft Paper Tubing. ○ □ ▭
22 Plain Diamond Insulation Tubing. ○
23 Plain Chipboard Tubing. ○

○ Round ⍋ Formed and Notched
△ Formed (fluted shape) □ ▭ Square, Rectangular

SELECTION OF THE PROPER GRADE

While the differences between some of the grades are not great, they are quite distinct when specific requirements are considered. For most uses, the proper grade can be selected from the descriptions, size range, and properties tables in our catalog. If this should prove difficult in some cases, it is desirable for our C-D-F sales engineer to have as much information as possible about the application, especially fabricating requirements, in order that we may make suggestions. Your blueprint is usually sufficient if it carries some indication as to the quality desired. In other cases, the following check list will be found to be helpful:

Type of Application.

Properties required or the customer's specification for the material.

Fabricating quality desired. This is important where stapling, riveting, punching, or forming operations are to be performed by the customer.

Any unusual conditions which may affect the suitability of the material for the job. For tubing that is to accommodate tuning cores, actual samples of the cores are essential along with torque requirements (if known).

See our general catalog in Sweet's Design File for more data, the address and telephone number of your nearest C-D-F sales engineer. Also write for 8-page Technical Folder ST-53 showing all grades of C-D-F Spiral Tubing, free test samples, or send us your print for quotation.

Continental-Diamond Fibre

CONTINENTAL-DIAMOND FIBRE COMPANY
NEWARK 16, DELAWARE

INTERNATIONAL RECTIFIER CORPORATION

EL SEGUNDO
CALIFORNIA

Selenium Rectifiers

POWER RECTIFIERS

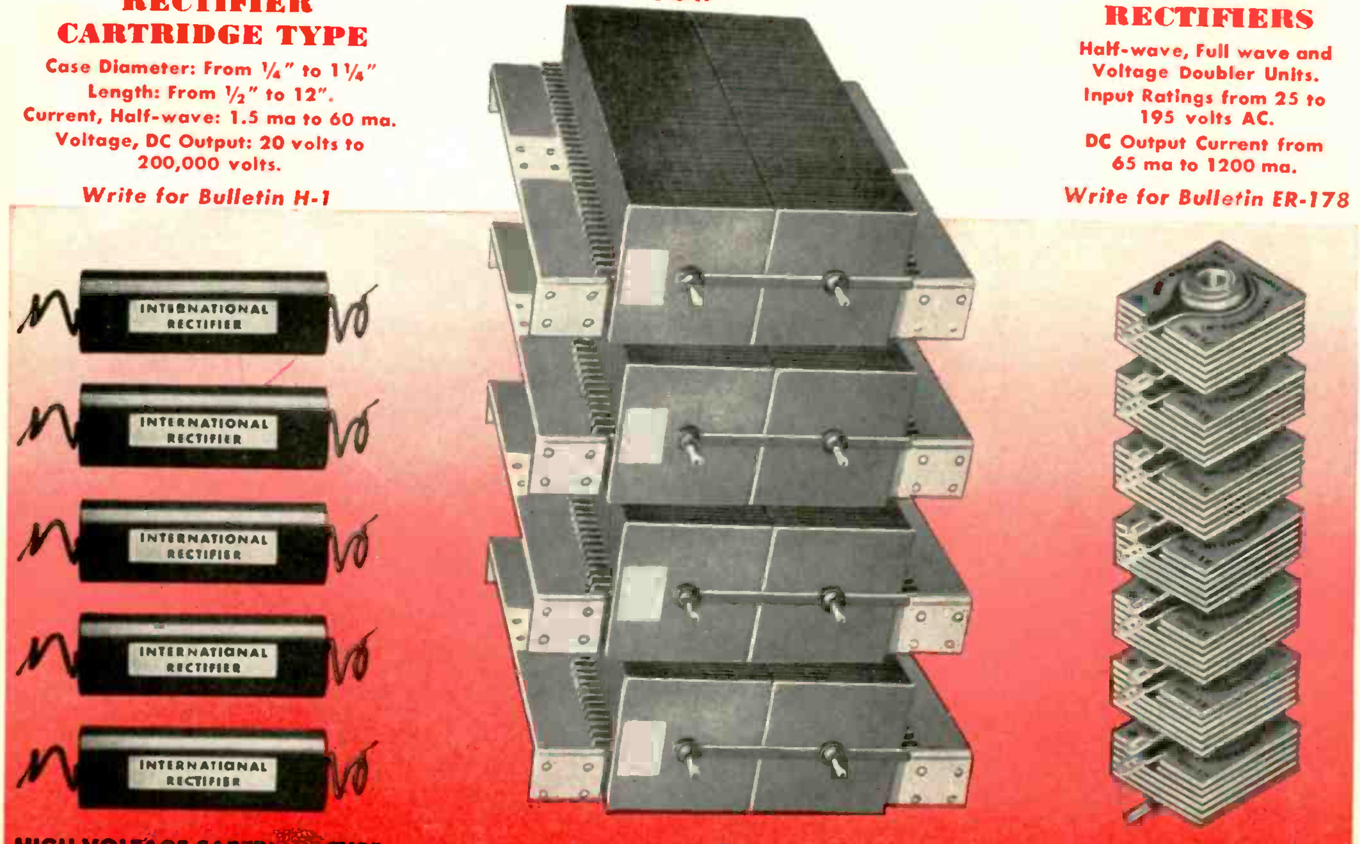
Widest range in the Industry
Power Factor 95%
Ratings to 250 KW
Efficiency to 87%
Write for Bulletin C-349

HIGH VOLTAGE RECTIFIER CARTRIDGE TYPE

Case Diameter: From ¼" to 1¼"
Length: From ½" to 12".
Current, Half-wave: 1.5 ma to 60 ma.
Voltage, DC Output: 20 volts to 200,000 volts.
Write for Bulletin H-1

MINIATURE RECTIFIERS

Half-wave, Full wave and Voltage Doubler Units.
Input Ratings from 25 to 195 volts AC.
DC Output Current from 65 ma to 1200 ma.
Write for Bulletin ER-178


INTERNATIONAL RECTIFIER
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INTERNATIONAL RECTIFIER
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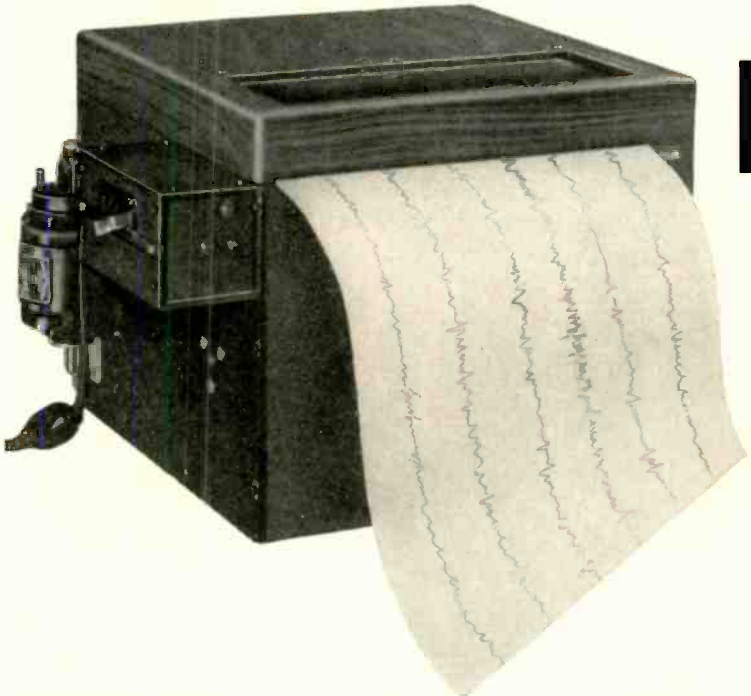
HIGH VOLTAGE CARTRIDGE TYPE **POWER RECTIFIERS** **MINIATURE RECTIFIERS**

INTERNATIONAL RECTIFIER CORPORATION

General Offices: 1521 E. Grand Ave., El Segundo, Calif. • Phone: ORegon 8-6281
Chicago Branch Office: 205 West Wacker Drive • Phone: Franklin 2-3889
New York Branch Office: 501 Madison Avenue • Phone: Plaza 5-8665

ON DISPLAY AT WESCON EXHIBIT, AUGUST 25-27

THE OFFNER DYNOGRAPH

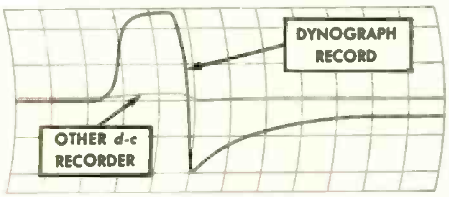


A direct-writing oscillograph for *absolutely drift-free recording!*

100 times as fast—*as recorders of comparable sensitivity*
30 times as sensitive—*as recorders of comparable speed**

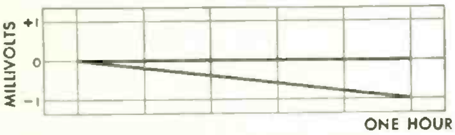
Do you need to record pressure—vibration—speed—acceleration—bioelectric potentials?—Now you can obtain a precise record of high-speed transients with this ruggedly built, easy to maintain, versatile *d-c* recorder.

TAKE A LOOK AT THE RECORD!



Compare the large, easily interpreted record from the Dynograph with the barely discernible record from the most sensitive competitive direct-writing *d-c* oscillograph. The record is made with 150 *microvolts d-c* per cm. of pen deflection—*thirty times the sensitivity of any competitive instrument.** You get eight cm. pen deflection . . . 1% linearity; a response speed of 1/120th of a second. Approximately 100 times the speed of other industrial recorders with comparable sensitivity. Yet the Dynograph is *completely stable:* it has zero base-line drift.

TAKE A LOOK AT THE RECORD!



This chart shows the base-line drift of a competitive recorder compared to the absolutely stable non-drifting Dynograph.

The Dynograph with *one amplifier* records *a-c* or *d-c* inputs, operates from strain gauges or reluctance gauges, records temperatures, rotational accelerations and velocities, records microvolts in the brain or thousands of volts and amperes in a rolling mill. Investigate the accuracy, economy, and convenience of the Dynograph—ask for Bulletin L-311.

---

*Based on manufacturers' published claims.

OFFNER ELECTRONICS INC.

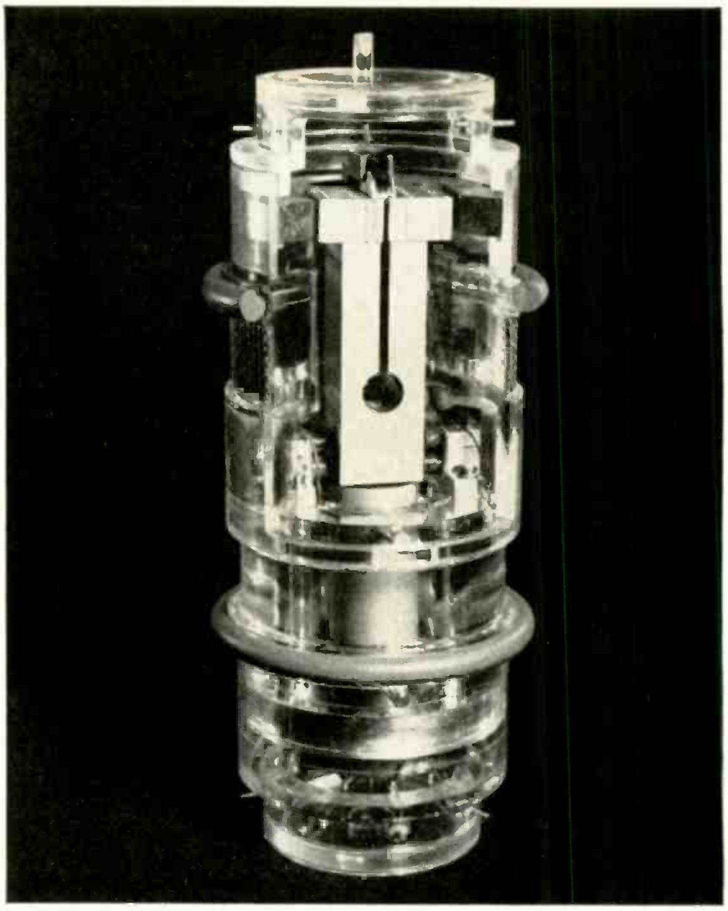
5320 N. Kedzie Avenue, Chicago 25, Illinois

West Coast Representative: Roland Olander and Company
7225 Beverly Blvd., Los Angeles 36, California

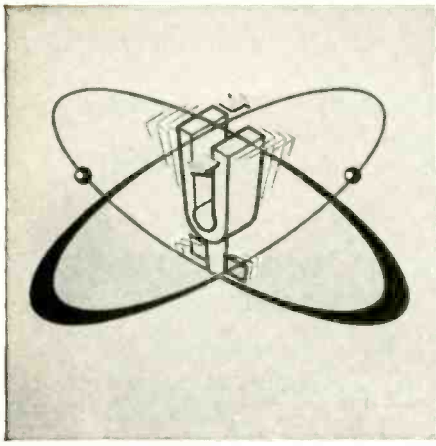
New England Representative: William Tunnicliffe
11 Orient St., Winchester, Massachusetts

How Sperry solved the metal problems in

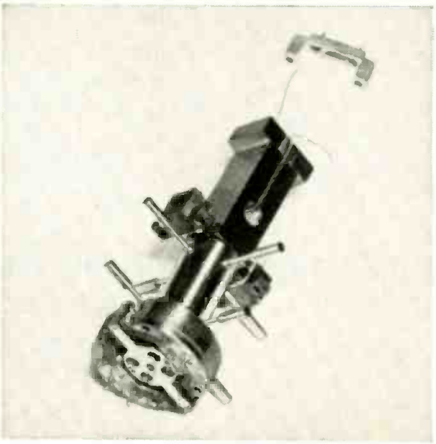
THE NEW "GYROSCOPE" THAT NEVER SPINS



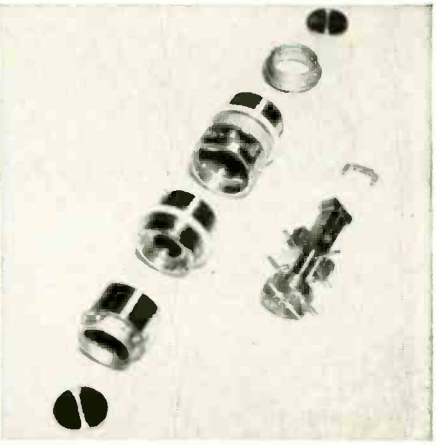
THIS IS THE GYROTRON*, Sperry's revolutionary new type of gyroscope that never spins. Driven without bearings, by electrical vibration, it can give precise measurements of the rate of turn in planes and missiles scorching along at supersonic speeds.



THE INCESSANT VIBRATION calls for a metal with unusual resistance to fatigue. Sperry designers found this property in Inconel® . . . and use Inconel for the vibrating heart of the Gyrotron — its "tuning fork."



INCONEL has other properties that are important in this "tuning fork." It is non-magnetic, tough, resistant to both wear and corrosion.



THE PROBLEM of matching special jobs to the right metal cropped up repeatedly as Gyrotron specifications were written. Every part, from permanent magnet to high permeability alloy to non-magnetic Inconel (except for an ounce or so of copper wire), is a nickel alloy.

When you have a new product on the boards, or plan to improve an old one, look to the INCO Nickel Alloys for the unusual combinations of properties you need. And look to INCO Technical Service for assistance on specific metal problems.

*GYROTRON is a registered trademark of The Sperry Gyroscope Company

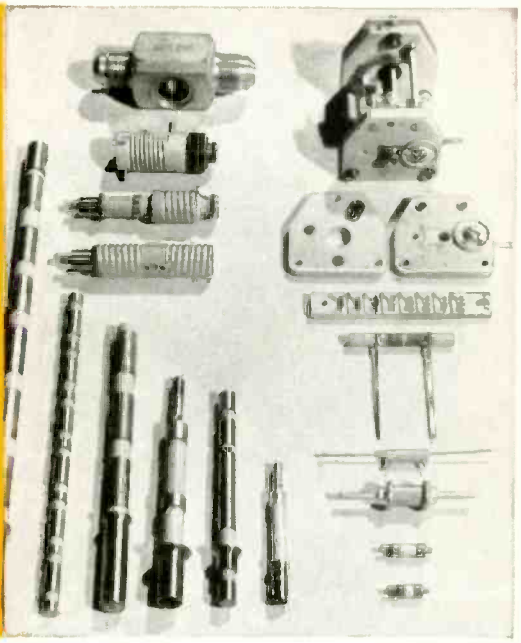
THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO NICKEL ALLOYS

INCO TRADE MARK

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL
"S"® MONEL • INCONEL® • INCONEL "X"® • INCONEL "W"®
INCOLOY® • NIMONIC® Alloys • NICKEL • LOW CARBON NICKEL
DURANICKEL®

ceramics and metal are permanently and accurately combined



The metal bands on the rotor shafts shown at the left, above, are concentric with the shaft to within 0.001 in.

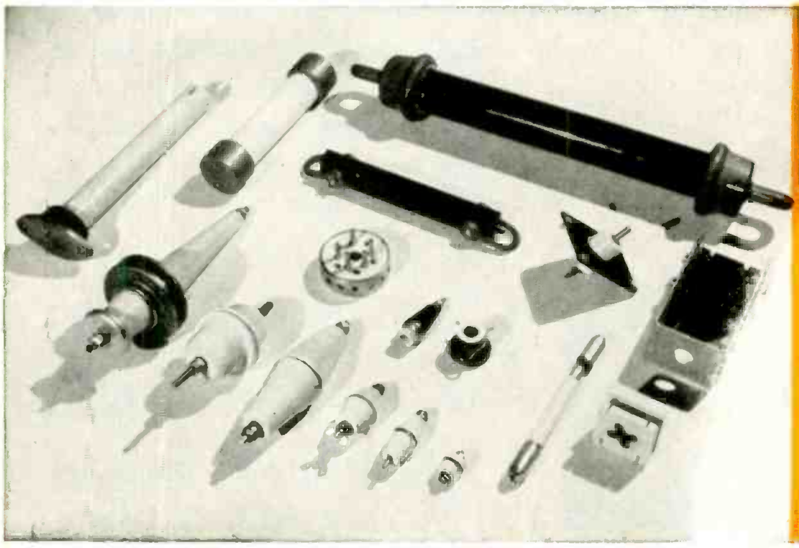
Stupakoff assemblies

Your production procedure is simplified when you use high-precision Stupakoff ceramic-to-metal assemblies. Extensive experience in the field of electrical and electronic ceramics, thorough familiarity with methods of metallizing, and the use of modern precision manufacturing methods insure the high quality and uniformity of Stupakoff Assemblies.

Among the assemblies made by Stupakoff are: rotor shafts, strain and spreader insulators, stand-offs and trimmers. Ceramic bodies are specially formulated for the intended service; metals used include silver, copper, brass, stainless steel and monel. Stupakoff's broad experience in this field insures the selection of a method of assembly best suited to meet service conditions.

A few types of Stupakoff Ceramic-to-Metal Assemblies are illustrated in the photographs on this page.

STUPAKOFF CERAMIC & MANUFACTURING COMPANY
LATROBE, PENNSYLVANIA



Some of the larger types of Stupakoff metallized ceramic parts.

Small metallized ceramic parts are accurately made and dependably uniform.

For high voltage wiring…
CORONA SHIELDS by Ucinite

Specially designed for television and other high voltage circuits, these Ucinite corona shields are made of cadmium-plated brass. With all sharp edges turned inward for maximum corona resistance, they provide excellent protection in electrical connections.

Ucinite is equipped to manufacture, assemble and wire to your specifications, a wide variety of electrical parts and assemblies for use in electronic apparatus of all types. For full information, call your nearest Ucinite or United-Carr representative, or write directly to us.

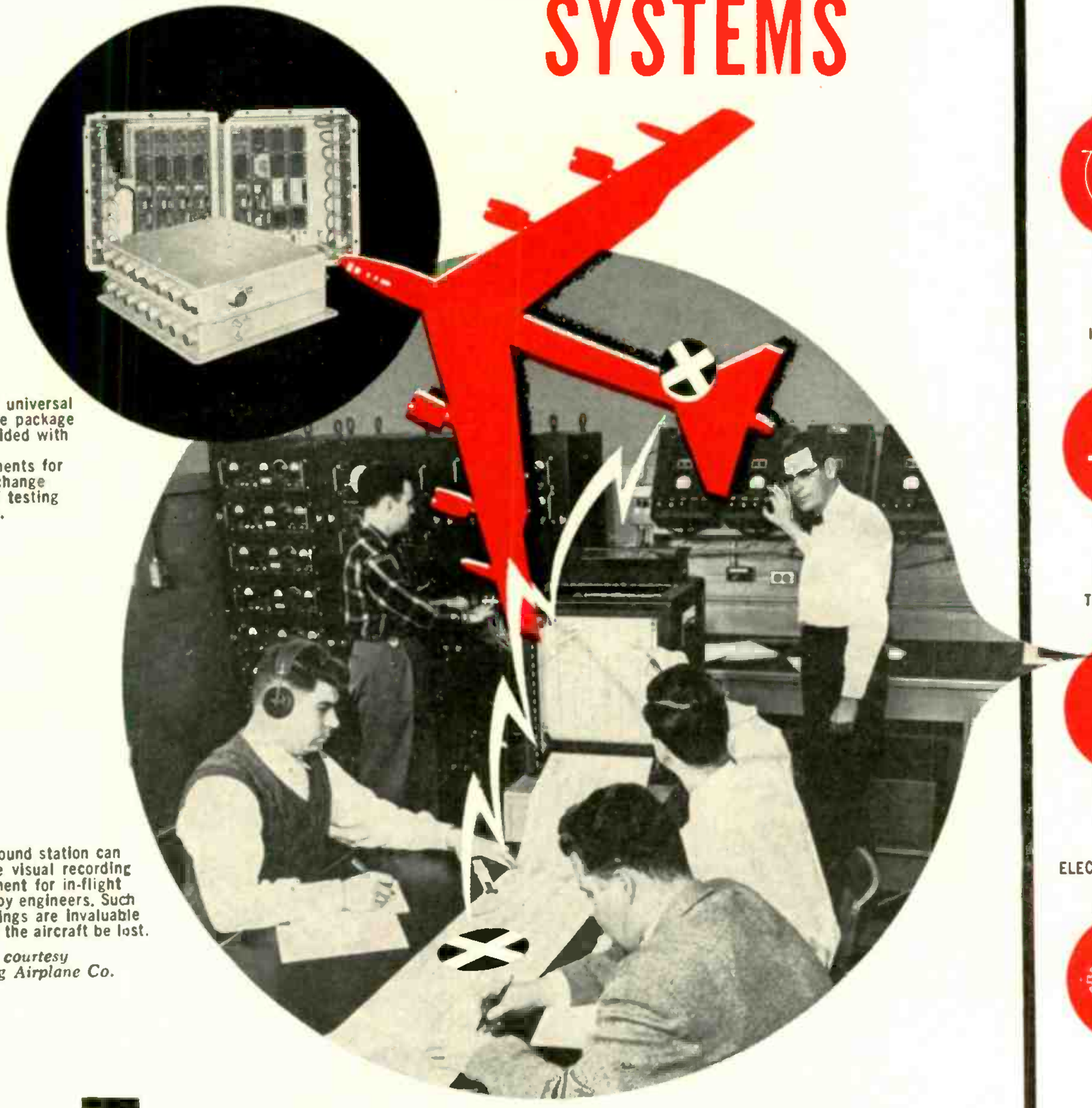
ELECTRICAL ASSEMBLIES
Ucinite
RADIO AND AUTOMOTIVE

The
UCINITE CO.
Newtonville 60, Mass.
Division of United-Carr Fastener Corp.

Specialists in
ELECTRICAL ASSEMBLIES,
RADIO AND AUTOMOTIVE

FASTER, SAFER, LESS EXPENSIVE FLIGHT TESTING

BENDIX-PACIFIC TELEMETERING SYSTEMS



Typical universal airborne package is provided with plug-in components for quick change over of testing factors.

The ground station can include visual recording equipment for in-flight study by engineers. Such recordings are invaluable should the aircraft be lost.

Photo courtesy Boeing Airplane Co.

RADAR

SONAR

HYDRAULICS

TELEMETERING

ELECTRO-MECHANICAL

ULTRASONICS

The flexibility and effectiveness of Bendix-Pacific Telemetering Systems are materially speeding up flight test programs for several air frame companies, and cutting costs at the same time.

Standardized Systems are available which provide for compact, lightweight airborne equipment and stable ground recording stations. The systems will measure any kind of information that can be recorded by older methods—and with an accuracy that can be depended upon.

The effectiveness of Bendix-Pacific telemetering equipment is being demonstrated in the wide range and multiplicity of information transmitted simultaneously. Numerous flutter tests, for example, can be observed and flight conditions varied by radio communication while a single flight is in progress. The crew is free to concentrate on flying the airplane. The system also offers an important safety factor by warning of any dangerous conditions.

BENDIX-PACIFIC TELEMETERING SYSTEMS Accurately Measure
Vibration • Temperature • Pressure • Acceleration • Strain • Motion

BENDIX PACIFIC

THE NAME Bendix AVIATION CORPORATION MILLIONS TRUST

PACIFIC DIVISION • Bendix Aviation Corporation
11600 Sherman Way, North Hollywood, California

East Coast Office:
475 5th Ave., N.Y. 17

Export Division: Bendix International
205 E. 42nd St., N.Y. 17

Canadian Distributors:
Aviation Electric, Ltd., Montreal 9

PRE-FLIGHT PRECAUTIONS

with

GOODMANS PERMANENT MAGNET SHAKERS

The flight characteristics of a newly designed aeroplane are the subject of lengthy calculations before the first prototype is built. Whilst the mathematical calculations are themselves accurate, they are based, as in all design work, on several assumptions which have to be verified by a series of pre-flight tests.

One of these essential investigations is the Ground Resonance test, the purpose of which is to determine the various complex modes of vibration of the airframe structure. The frequency of the mode and the dynamic response at remote parts of the aircraft must be accurately determined. The information obtained together with the aerodynamic derivatives is used in predicting the critical 'flutter' speed of the aircraft. The illustration shows one of the two Goodmans Model 8/600 Shakers which were used to excite the Handley Page 'Victor' for this very important test.

For wide frequency range vibration testing and dynamic response investigations, Goodmans Shakers are an obvious choice. These units require no field excitation and provide a faithful reproduction of the input wave form. Industrial applications of controlled vibration are continually increasing; maybe it can serve you—in which case our unique experience is at your service.

Just another of the wide applications of Goodmans Shakers

The range includes models from the 8/600 shown, developing a force of ±300 lb., to the midget model, with a force of ±2 lb., for optical cell research and hairspring torque testing, etc.

MAIL THIS COUPON

TO GOODMANS INDUSTRIES LIMITED
AXIOM WORKS, WEMBLEY, MIDDX., ENGLAND

Please mail me your catalogue and technical data sheets in connection with your PERMANENT MAGNET Shakers.

NAME ....

COMPANY ....

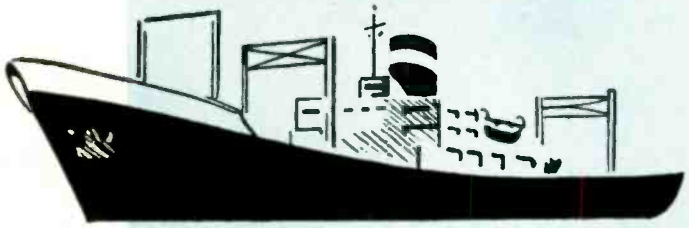
CITY.............................. ZONE...... STATE................ E/U

GOODMANS INDUSTRIES LTD.

AXIOM WORKS • WEMBLEY • MIDDX • ENGLAND

Cables: GOODAXIOM WEMBLEY, MIDDX.

THE CHOICE FOR MARINE APPLICATIONS



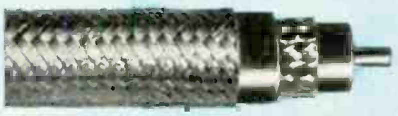
Federal QUALITY-CONTROLLED COAXIAL CABLES

. . . serve on the Seven Seas with the same dependability they bring to ALL transmission requirements of communications and industry!

FEDERAL'S Armored RG Types

Outstanding for ruggedness, efficiency and reliability

RG-10/U · RG-12/U · RG-18/U
RG-20/U · RG-35/U · RG-74/U
RG-79/U



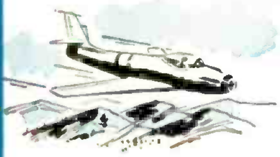
RG-18/U

RG-12/U

RG-79/U

Remember: Federal is the manufacturer of "America's most complete line of solid dielectric cables." Tell us your needs!

Federal
QUALITY-CONTROLLED



AVIATION

BROADCASTING

TEST EQUIPMENT

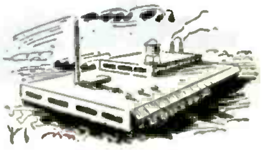
YOURS FOR THE ASKING: Federal's new 28-page buying guide contains a world of information on Federal quality-controlled wires and cables, plus numerous tables and diagrams. For your free copy write to the department above.

On ships at sea . . . plowing through all kinds of weather . . . from sub-zero regions to the tropics! *That's* where coaxial cables receive the supreme test of *dependability* . . . operating radar, direction finders, Loran, RF power and general communications . . . safeguarding human life and valuable cargoes!

Marine applications are only one of the many fields where Federal quality-controlled coaxial cables are the choice of designers and engineers for *trustworthy transmission!*

In aviation, industry, broadcasting, TV, test, experimental, pulse or special purpose . . . for HF, VHF or UHF anywhere . . . you'll find the best in *quality* and *performance* in Federal's RG types. Write us today about your specific requirements, to Dept. D-113A

RADAR, PULSE, EXPERIMENTAL EQUIPMENT AND SPECIAL TYPES



INDUSTRIAL

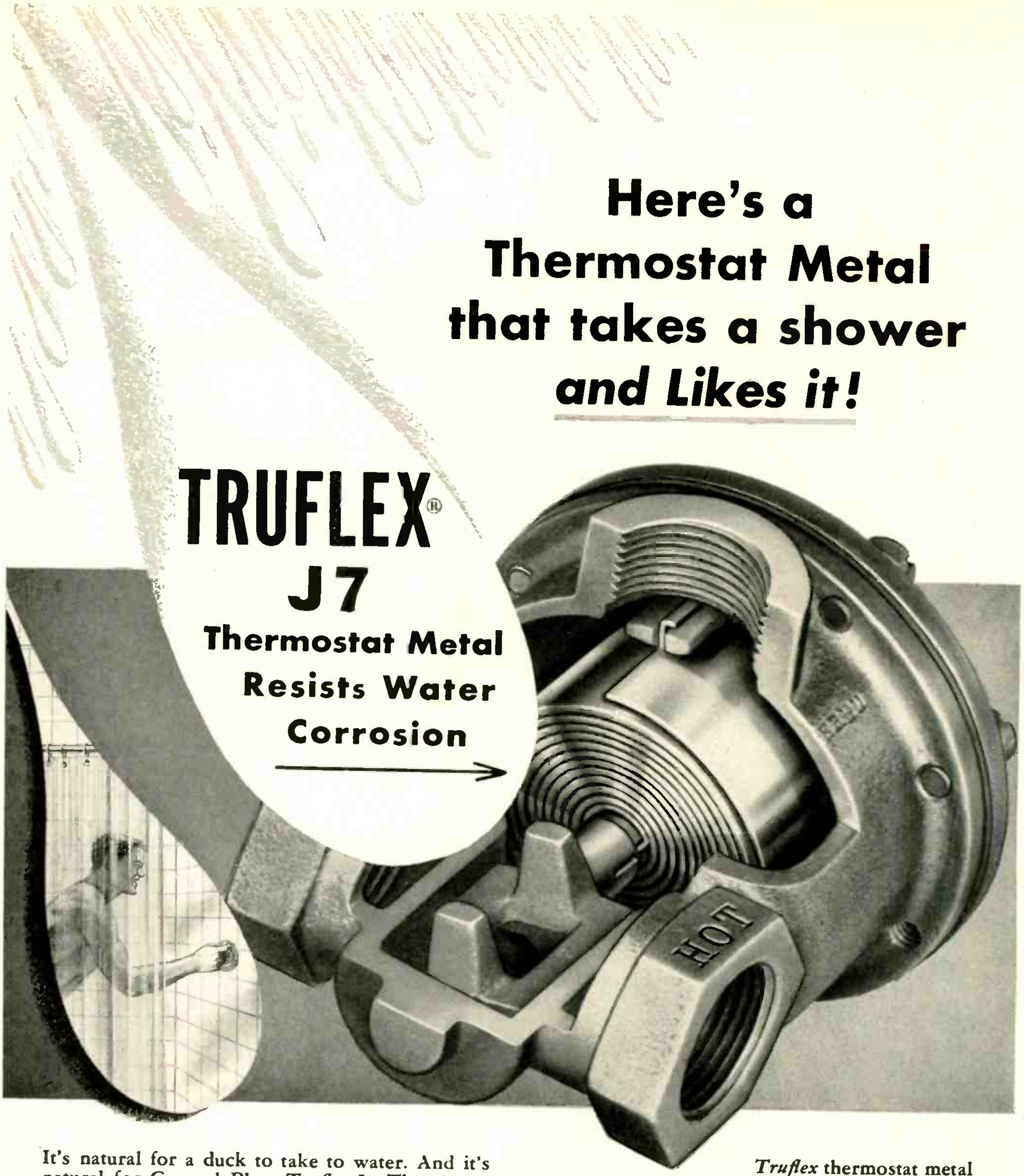
FEDERAL TELEPHONE & RADIO
FTR
DIVISION OF IT&T

Federal Telephone and Radio Company

A Division of INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
SELENIUM-INTELIN DEPARTMENT 100 KINGSLAND ROAD, CLIFTON, N. J.
In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., N. Y.

GET YOUR DC from AC with dependable, long-life Federal Selenium Rectifier Power Supplies.

Here's a Thermostat Metal that takes a shower *and Likes it!*



It's natural for a duck to take to water. And it's natural for General Plate *Truflex* J7 Thermostat Metal to operate without corrosion in water. Take for example the shower mixing valve illustrated. This and similar coils have operated continuously in showers and hot water tanks for over 15 years without failure due to corrosion.

Other *Truflex* J7 Thermostat Metal coils are operating successfully in such applications as hot water temperature measuring valves, tanning applications which often operate in mild acids, radiator valves and the like.

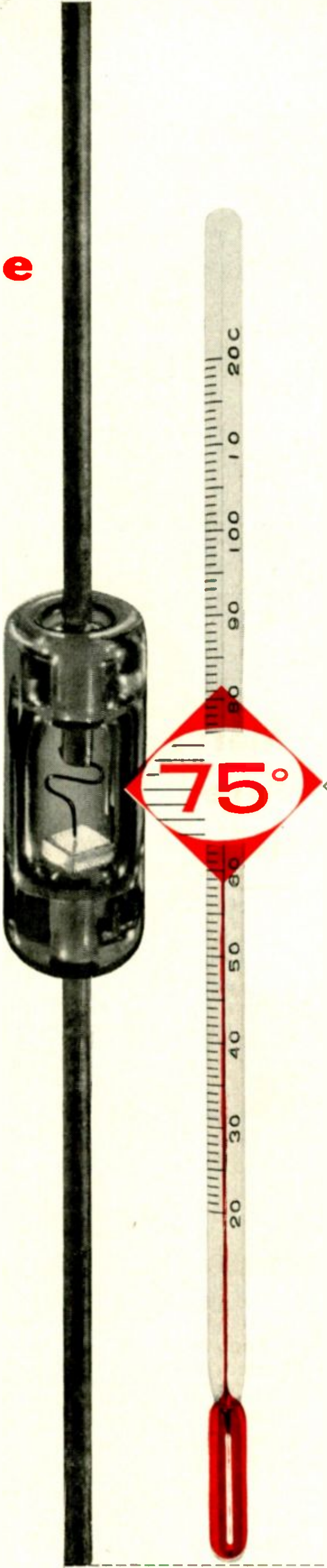
You, too, can obtain constant and accurate performance in your products because General Plate fabricates to your exact specifications, complete *Truflex* thermostat metal units ready for installation. You get reliable performance because every order comes to you an exact duplicate of the original . . . consistently uniform in tolerances, temperature reaction and performance, thus preventing rejects and costly adjustments in assembly.

For you who desire to manufacture your own parts, *Truflex* Thermostat Metals are available as strip in coils or flat cut lengths. Write for engineering assistance and catalog.

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
37 FOREST STREET, ATTLEBORO, MASS.

A Hi-Temperature Tested Germanium Diode

The new Hughes type 1N198



Temperatures inside operating equipment usually climb well above the equipment ambient temperature. At these elevated temperatures, you need components with *known* characteristics. Most germanium diodes are tested at room temperature and, as operating temperatures rise, their performance deteriorates. But the new Hughes Type 1N198 is a *realistic* germanium point-contact diode.

That's because this diode is tested 100% at 75°C—which is just about as hot as most electronic equipment gets in operation. In addition, samples of the 1N198 are regularly subjected to all standard tests at 25°C. This means that you can use these hi-temperature tested diodes with confidence, can design equipment to take full advantage of the fact that *electrical characteristics at the higher temperatures are specified.*

Type 1N198 Electrical Characteristics

at 75°C	
Forward Current at 1V dc	5 mA (Min.)
Reverse Current at —10V dc	0.075 mA (Max.)
Reverse Current at —50V dc	0.250 mA (Max.)
at 25°C	
Forward Current at 1V dc	4 mA (Min.)
Reverse Current at —10V dc	0.010 mA (Max.)
Reverse Current at —50V dc	0.050 mA (Max.)

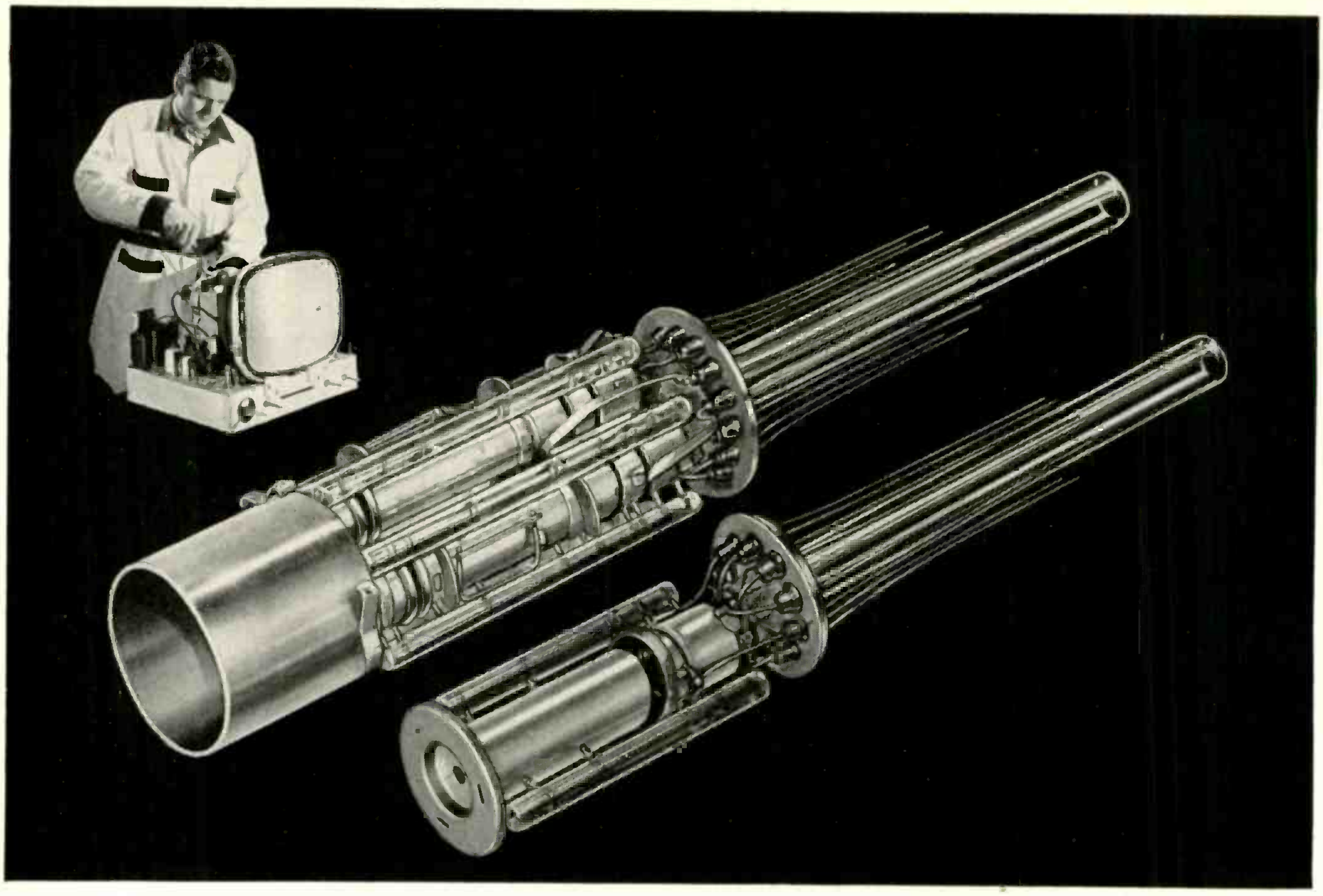
Like all Hughes Diodes, the hi-temperature tested 1N198 is fusion-sealed in a one-piece, gas-tight glass envelope which is impervious to moisture or other external contaminating agents. The complete Hughes line of fusion-sealed germanium diodes comprises standard RETMA, JAN, and many special types. We'd like to send our Bulletin SP-2A, which lists and describes these diodes, to you. Just send for your copy, or for additional details concerning the new Type 1N198.

Hughes

Aircraft Company, Culver City, Calif.

SEMICONDUCTOR SALES DEPARTMENT

New York Chicago



Miniature TV Tri-color cathode gun solves designer's dilemma

Sometime this year, a fortunate few thousand TViewers who can pay the freight will relax at home and watch their favorite stars cavort in color. Back of each screen is a triumph of engineering magic—a tri-color cathode ray gun, actually 3 cathodes—one for each primary color.

To bring color TV within pocketbook range of all of us, the heart of future guns will be a miniaturized version of the present disc cathode. The tubular nickel shank of this new disc cathode has been shortened from .312″ to .220″ and the outside diameter decreased from .121″ to .090″, resulting in a number of improvements adding to the efficiency of the assembly.

Cathode surface area is reduced. Smaller and shorter heaters used. Less power required (300-450 milliamps instead of the 600 required in older guns).

Lower heat radiation, due to less power, offers a constant heat as well as a cooler continual operation.

A smaller shank and cap which will not dish-in offers better transmission of electrons to the TV screen.

Smaller guns permit a more compactly assembled 3-gun unit. By moving guns closer together, the deflection of the electron beams is more closely controlled.

Miniaturization of the guns means a smaller neck on the finished TV tube. The 3-barrel color tubes take little more space than black and white types, and vital space is conserved for set manufacturers.

The advantages of the present larger disc cathode for monochrome guns—wide choice of material for cap and shank; close "E" dimension control—are also incorporated in the new design.

If you're interested in more information on materials used in the new disc cathode, and details on Nickel and Nickel Alloy Tubing, mail coupon today for a blueprint and Data Memo 5 and 19. There's no obligation.

Superior Tube Company, 2500 Germantown Ave., Norristown, Pa.
Electronics Division.

Please send: ☐ Blueprint ☐ Data Memo 5 and 19 on Superior Nickel and Nickel Alloy Tubing.

Name______________________________

Company______________________________

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The big name in small tubing

All analyses .010″ to ⅝″ O.D.
Certain analyses in light walls up to 2½″ O.D.

An Insurance Policy that Saves You Manufacturing Costs
Included in every shipment of Erie Capacitors

ERIE®
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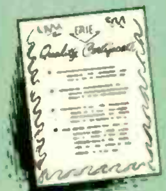


What is an ERIE Quality Certificate?

An Erie Quality Certificate is a form that lists the results of both electrical and mechanical tests for every shipment of Erie Capacitors. These tests are made by competent quality control inspectors using modern and precise measuring equipment.

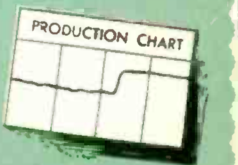
Will it Cut Costs?

YES — With the Quality Certificate you cut costs by reducing incoming inspection. You save the bother, time, and expense of returning faulty material because you are dealing with capacitors of a known quality. You also reduce the risk of putting faulty capacitors in your products.

Here's an Extra Dividend!

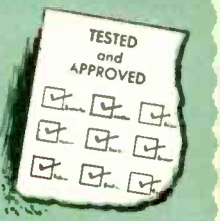
Erie Quality Certified capacitors cost you no more than other kinds. You benefit because quality products are always cheaper to use and add quality to your finished products.

Will it Speed Production?



YES — It takes less time for Quality Certified Erie capacitors to get from your receiving doors to your production lines. It eliminates costly trouble-shooting delays on your assembly line and in your inspection of the finished products.

What Does the Quality Certificate Offer?



The Quality Certificate lists the sample size and test results for each inspection sequence or series of inspection tests. The frequency distribution of capacitance values in the sample is also shown.
Electrical tests include dielectric strength, insulation resistance, and dissipation factor. Other tests such as temperature coefficient, case insulation breakdown are performed and results listed where applicable. The certificate also contains a complete inspection check list for mechanical and visual items. The sampling tables used are MILITARY STANDARD 105 with AQL's (Acceptable Quality Level) ranging from 0.4% for performance items to 1.5% for non-functional deviations.

Again the Pioneer

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As in so many other important developments in electronic components, Erie again leads the field. Erie is the first ceramic capacitor manufacturer to give customers this complete quality information with each shipment.

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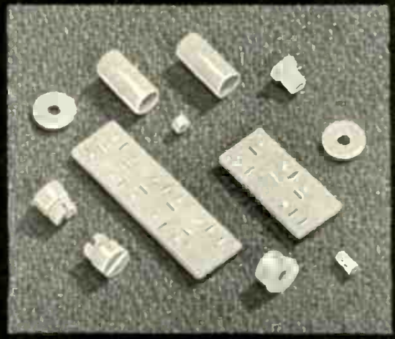
GLASS PREFORMS — Iron Sealing and Kovar Sealing Glass precision molded to the closest tolerances in the industry. Resist mercury attack, have ample mechanical strength, and seal readily. Our laboratory is prepared to assist you in selecting the proper glass for any metal.

FORMULA 800 PREFORMS — Mansol's newest development — using an Epoxy Resin to improve product efficiency. Possesses extremely high bonding strength, with no shrinkage, on metals to metals and metals to non-metals. Worth looking into! Can save you many man-hours of expensive labor.



STEATITE PREFORMS — We specialize in die pressed ceramics held to the closest tolerances. All tools and dies are made in our own shop to assure quick delivery.

NEW PLANT AND FACILITIES — We are proud of our modern, new plant devoted entirely to the development and production of all types of preforms.

Research, Engineering and Manufacturing skills guarantee the highest standards of . . .

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HOW MANSOL SOLVES PREFORM PROBLEMS — The complete story concerning our services, facilities and production techniques can be had free of charge just by writing to Dept. N, Mansol Ceramics, Belleville, New Jersey.

INVESTIGATE MANSOL'S TECHNICAL KNOW-HOW TODAY AT NO COST OR OBLIGATION. Mansol's engineers are at your service, ready to discuss your powder molding problems, whether they be glass for seals, spacers, or lead through bushings.

If you are still making your own preforms, Mansol would like to show you how to save money by eliminating rejects.

GS SERIES

for TRUE HERMETIC SEALING

Canseals *by cannon*

Hermetically-sealed multi-contact Canseal connectors made by Cannon are really rugged! And . . . they are the only connectors that give you **true hermetic sealing under adverse pressure and atmospheric changes.** Here's why . . .

Cannon pioneered the first successful hermetically-sealed connector more than six years ago . . . since then has continously refined and increased the line. All have special steel contacts. Glass insulation . . . **fused to both contacts and shell for a perfect permanent seal** . . . is stronger than steel, withstands temperatures to 1000° F, and permits the use of the **highest conductive steel** contacts compatible with any glass fusing operation.

Available in a wide variety of insert layouts for control, relay, power, and instrument applications in Series GS (AN type), KH, RKH, U, DAH, BFH, TBFH, DBH, DCH, KH30 standard, miniature and sub-miniature sizes. Also, special mounting flanges and brazing service to help you obtain a strong and leakproof overall assembly.

CANNON PLUGS

first in connectors

DH SERIES

U SERIES

KH SERIES

Please refer to Dept. 120

CANNON ELECTRIC COMPANY, 3209 Humboldt Street, Los Angeles 31, California

Factories in Los Angeles; East Haven; Toronto, Canada; London, England.
Representatives and distributors in all principal cities are at your service.

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Look to PHELPS REALISTIC APPROACH TO

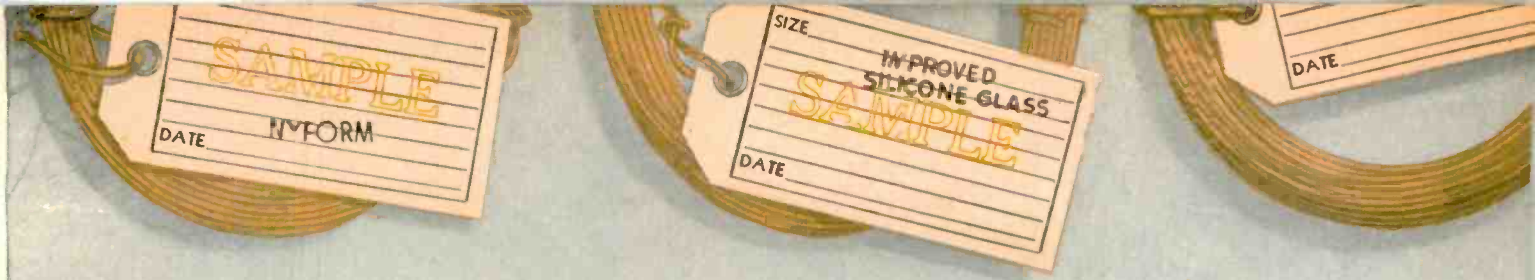
✓ **PRACTICAL KNOWLEDGE** of magnet wire application problems and trends.

✓ **CONTINUING INVESTIGATION** of existing insulations to improve quality and performance.

✓ **EXHAUSTIVE TESTING** and evaluation of new organic and inorganic insulation materials to determine fundamental properties and application possibilities.

✓ **ENGINEERING ASSISTANCE** in selection and use of exactly right magnet wire for specific motor, transformer or coil.

First for Lasting Quality—from Mine to Market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IMPROVED SILICONE GLASS
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DODGE for a MAGNET WIRE RESEARCH!

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SILICONE ENAMEL
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DATE
SIZE
RECTANGULAR FORMVAR GLASS
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DATE

Result: **Economical solutions to many varied and complex application problems!**

The magnet wires pictured here illustrate the wide range of the Phelps Dodge line. Some of these wires—developed specifically by Phelps Dodge to answer special problems—suggest unlimited new applications for the future with overall savings to the user. Bondeze and Sodereze are examples of this kind of research.

Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer!

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CORPORATION

INCA MANUFACTURING DIVISION
FORT WAYNE, INDIANA

for Accuracy

USE KAY

ALL-ELECTRONIC WIDE RANGE SWEEP GENERATORS

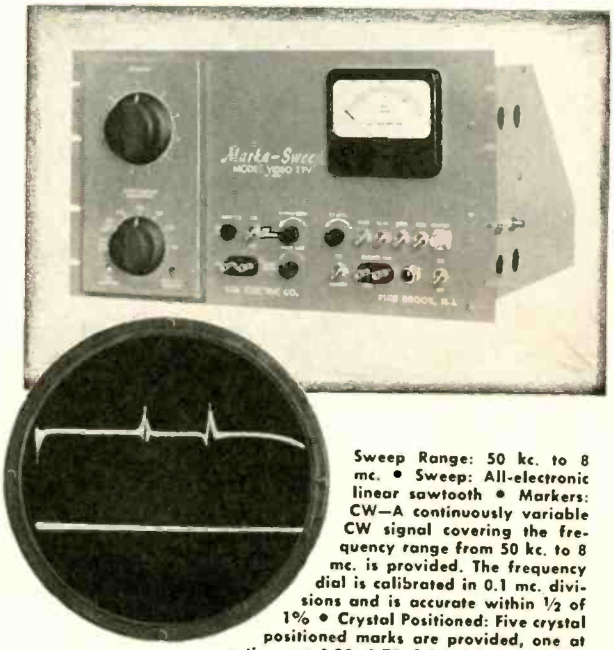
Sweep: All-electronic linear sawtooth • Markers: Six very sharp crystal positioned pulse-type marks are provided at 1, 2, 5, 10, 15, and 20 mcs. A variable frequency mark of the same type is formed by an external signal generator at any desired frequencies within the video range. If desired, special crystal positioned marks may be substituted for standard ones • Amplitude Modulation while Sweeping: to 10 mc.—less than .05 db/mc.; to 20 mc.—less than .1 db/mc. • Output Voltage: 0.3 volts at 72 ohms • Output Attenuators: Switched—20 db, 20 db, 10 db, 3 db. Continuous—Approx. 6 db • Marker Output Voltage: Positive pulse, approx. 10 volts peak • Marker Output Control: Continuously variable, 0 to maximum • Catalog No. 150-A • Price: $495.00 f.o.b. factory (Special crystal positioned marks substituted at $10 ea.)

THE MODEL VIDEO MARKA-SWEEP

A Wide-Range Sweep Covering the Whole Video Frequency Band in One Sweep.

THE MODEL VIDEO MARKA-SWEEP has an extremely wide sweep width covering either 50 kc. to 5 mc., 50 kc. to 10 mc., or 50 kc. to 20 mc. in a single sweep. These three ranges are selected by a rotary switch on the panel of the instrument. In conjunction with an oscilloscope it will display the response curves of video amplifiers, as well as marking several frequencies for identification. By us of an external signal generator a variable frequency pulse-type mark is available.

The sweeping oscillator is actuated by a sawtooth generated within the instrument. This voltage is available at output terminals for deflection of the oscilloscope. A true zero level baseline is produced on the oscilloscope display during the retrace time. The output levels of sweep signals and marker pulses are adjusted by separate controls.



Sweep Range: 50 kc. to 8 mc. • Sweep: All-electronic linear sawtooth • Markers: CW—A continuously variable CW signal covering the frequency range from 50 kc. to 8 mc. is provided. The frequency dial is calibrated in 0.1 mc. divisions and is accurate within ½ of 1% • Crystal Positioned: Five crystal positioned marks are provided, one at a time, at 0.20, 0.75, 1.25, 4.0 and 6.0 mc. If desired, special crystal positioned marks may be substituted for standard ones. • Amplitude Modulation While Sweeping: Less than 0.05 db/mc. • Output Voltage: Sweep, CW and Crystal frequencies—each 4.2 volts, peak to peak, into 72 ohms (1.5 volts, r.m.s.). Peak to peak and r.m.s. reading voltmeter provided at output, accurate within approx. 5% • Output Attenuators: Switched—20 db, 20 db, 10 db, 3 db. Continuous—Approx. 26 db. • Marker Output Control: Continuously variable, approx. 5 db. • Catalog No. 151-A • Price: $695.00 f.o.b. factory, for rack mounting. (Special crystal positioned marks substituted at $10 ea.) Note: Cabinet $35 extra.

THE MODEL VIDEO TTV MARKA-SWEEP

Combines a Sweep covering the Whole TV Video Frequency Band with Variable CW plus Crystal Positioned Markers. For checking Television Transmitters.

THE MODEL VIDEO TTV MARKA-SWEEP has a wide sweep width covering 50 kc. to 8 mc. in a single sweep. A front panel rotary selector switch selects variable CW or any one of five crystal controlled frequencies. In conjunction with an oscilloscope it will display the response curves of video amplifiers. Variable CW and crystal controlled outputs are available for single frequency checks and for providing variable and/or crystal positioned marks on the response curve.

By simple switching any combination of variable CW, crystal controlled signal and sweep are provided simultaneously. The crystal frequencies are also convenient for accurately calibrating the CW frequency dial.

The sweeping oscillator is actuated by a sawtooth voltage generated within the instrument. This voltage is available at output terminals for deflection of the oscilloscope. A true zero level baseline is produced in the oscilloscope display during the retrace time. The output levels of marker and sweep signals are adjusted by separate controls. Output levels are indicated directly on a voltmeter with both peak-to-peak and r.m.s. scales.

KAY ELECTRIC COMPANY
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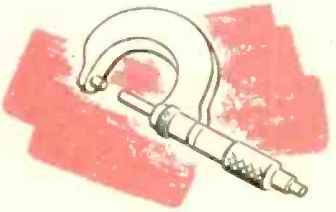
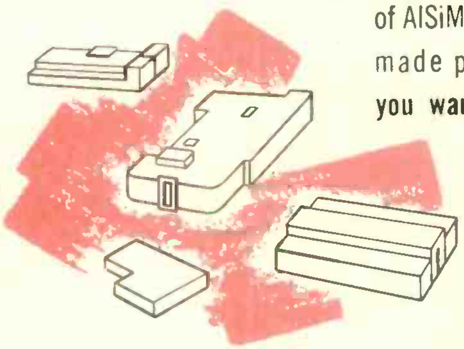
Your line workers will appreciate the ease and speed with which they can assemble AlSiMag ceramics. Your production planning staff will be well pleased with the excellent quality as well as the rapid delivery of these parts.

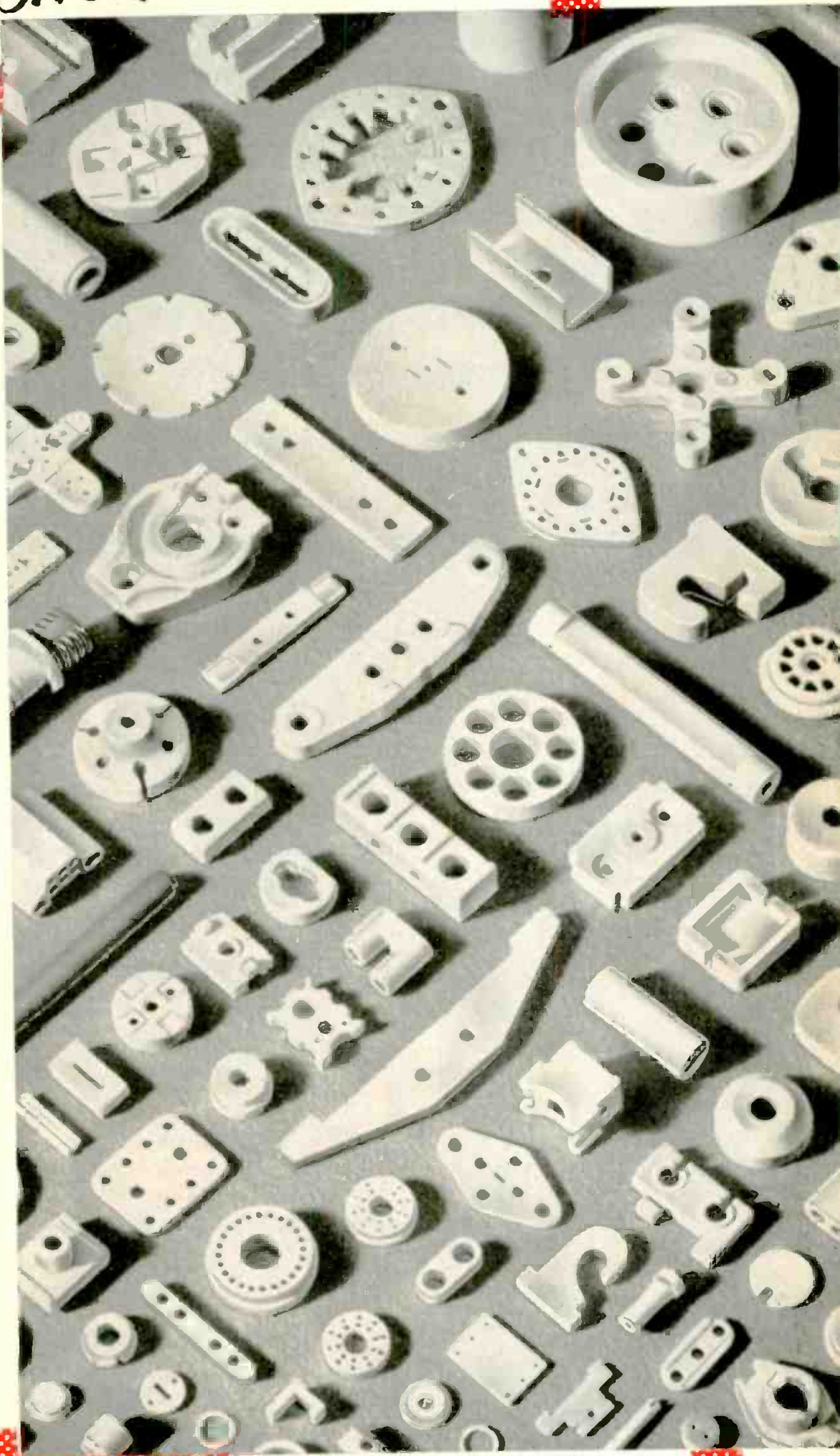


Physical dimensions and tolerances are checked at every key stage of manufacture by thoroughly trained Quality Control inspectors to insure shipment of a superior product.

Four large, completely equipped plants assure you of hundreds—or hundreds of thousands—of AlSiMag precision made parts when you want them.



You can confidently specify AlSiMag ceramics—backed by over fifty years of specialized experience in the technical ceramics field.



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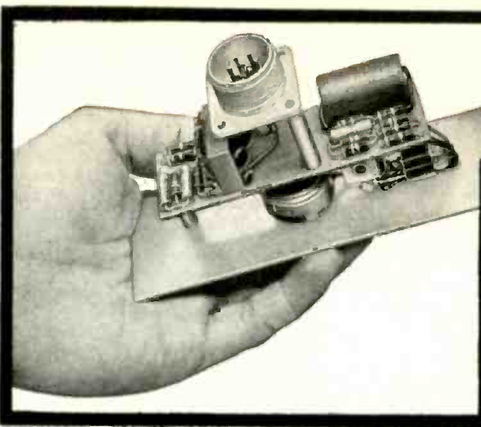
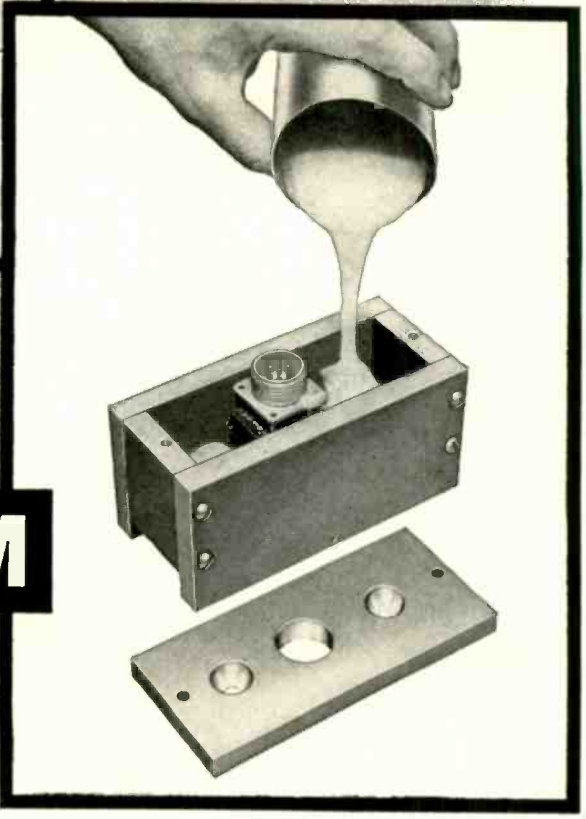
this control needed protection

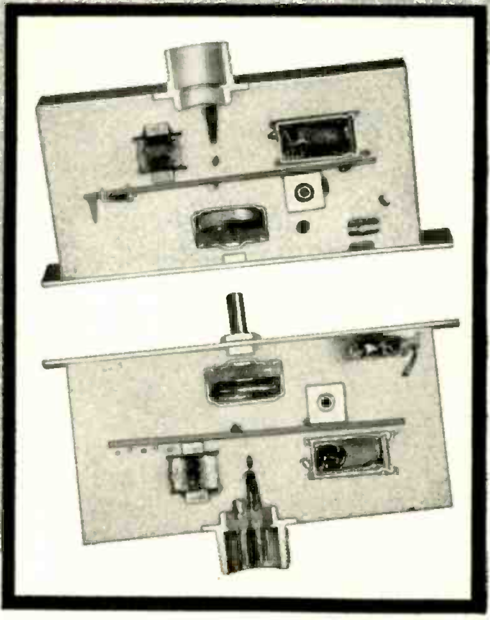


here's the easy way they protected it with

NOPCO® LOCKFOAM



result: a complete barrier against vibration, corrosion, dampness, fungi



Hamilton Standard Division, United Aircraft Corporation, needed a potting material for the electronic temperature control unit that governs cockpit air-conditioning—found Nopco Lockfoam ideal for the purpose.

Nopco Lockfoam is indeed ideal for this and many other similar tasks because of the absolute protection it affords against damage from severe vibration. Its light-weight closed-cell structure makes a tamper-proof assembly, and gives a high impermeability to dampness, corrosion, and fungi growth. Also, its pour-in-place technique effects great economy of assembly time.

Further, each of the 50 different formulations available is highly consistent and reproducible.

Perhaps the rare combination of properties of this versatile plastic can help with some product *you* have in mind. *Write today for the Nopco Lockfoam booklet.*

Where Can YOU Best Use These Properties?

Near-perfect
Radar Transmission

Ease of Fabrication
It's "poured-in-place"

Great Strength
with Light Weight

Excellent Electrical Properties
6 lb/cu ft Lockfoam tested
at 9.375 KMC
Dielectric Constant 1.05
Loss Tangent .0005

Good Thermal Insulation
"K" Factors
.018 at 8 lb/cu ft
to .025 at 11 lb/cu ft

Wide Range of Densities
From 2 to 35 lb/cu ft

Great Versatility
50 different formulations
available

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S EALED
S HIELDED
S TABILITY

HS SERIES TOROIDS

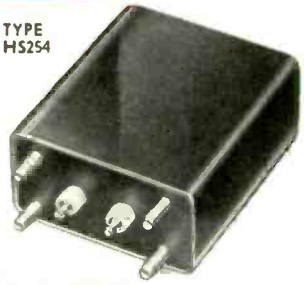
For IMMEDIATE Delivery

TYPE
HS715

DIMENSIONS

Length .... 2-9/16"
Width .... 1-5/16"
Height .... 2-13/16"
Weight .... 14 oz.
Mounting .... 2-1/16 x 1 /16"
Screws .... 6/32" studs
Cutout .... 7/8 x 1/2"

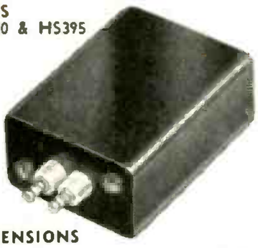
TYPE
HS254



DIMENSIONS

Length .... 1-29/32"
Width .... 1"
Height .... 2-1/4"
Weight .... 8 oz.
Mounting .... 1-5/16 x 9/16"
Screws .... 6/32" studs
Cutout .... 7/8 x 1/2"

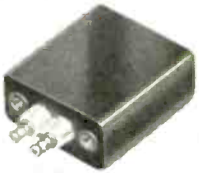
TYPES
HS930 & HS395



DIMENSIONS

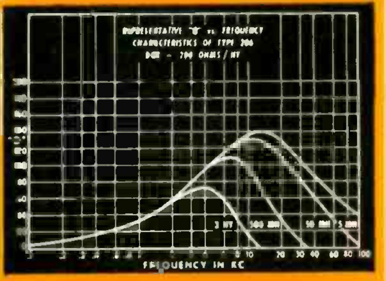
Length .... 1-9/32"
Width .... 11/16"
Height .... 1-23/32"
Weight .... 4 oz.
Mounting .... 7/8 x 9/32"
Screws .... 4/40" studs
Cutout .... 1/2 x 5/16"

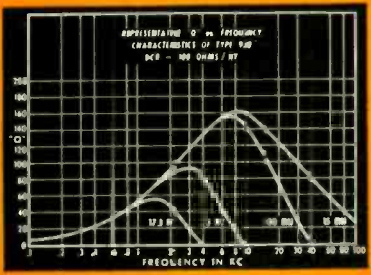
TYPES
HS206, HS848
HS608 & HS073

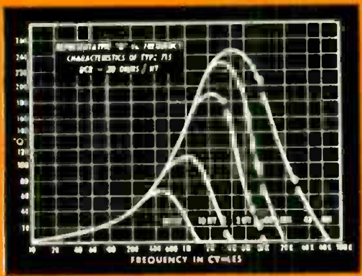


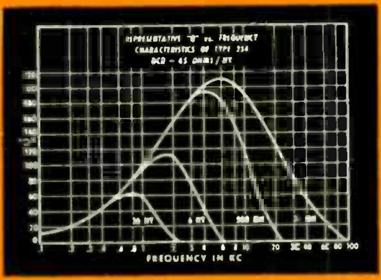
DIMENSIONS

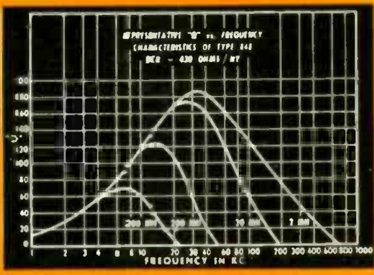
Length .... 1-1/16"
Width .... 1/2"
Height .... 1-1/4"
Weight .... 1.5 oz.
Mounting .... 3/4"
Screws .... 4/40" studs
Cutout .... 1/2 x 5/16"

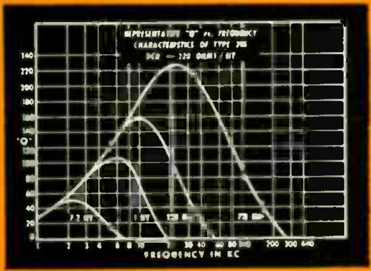


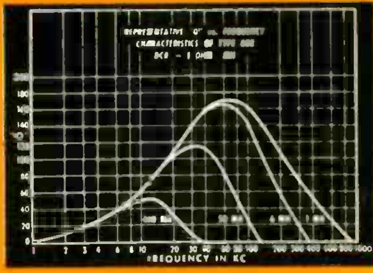


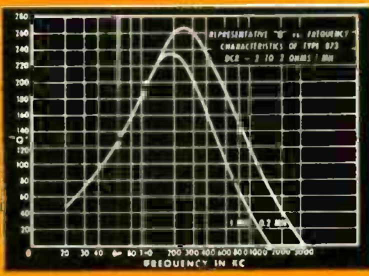












LIST OF STOCKED UNITS

All other values and types on Special Order

Suffix Number	HS 206—	HS 930—	HS 254—	HS 715—
— 1	5.0 MH	5.0 MH	20 MH	24 MH
— 2	6.0 MH	6.0 MH	24 MH	30 MH
— 3	7.2 MH	7.2 MH	30 MH	36 MH
— 4	8.6 MH	8.6 MH	36 MH	43 MH
— 5	10 MH	10 MH	43 MH	50 MH
— 6	12 MH	12 MH	50 MH	60 MH
— 7	15 MH	15 MH	60 MH	72 MH
— 8	17.5 MH	17.5 MH	72 MH	86 MH
— 9	20 MH	20 MH	86 MH	100 MH
—10	24 MH	24 MH	100 MH	120 MH
—11	30 MH	30 MH	120 MH	150 MH
—12	36 MH	36 MH	150 MH	175 MH
—13	43 MH	43 MH	175 MH	200 MH
—14	50 MH	50 MH	200 MH	240 MH
—15	60 MH	60 MH	240 MH	300 MH
—16	72 MH	72 MH	300 MH	360 MH
—17	86 MH	86 MH	360 MH	430 MH
—18	100 MH	100 MH	430 MH	500 MH
—19	120 MH	120 MH	500 MH	600 MH
—20	150 MH	150 MH	600 MH	720 MH
—21	175 MH	175 MH	720 MH	860 MH
—22	200 MH	200 MH	860 MH	1.00 HY
—23	240 MH	240 MH	1.00 HY	1.20 HY
—24	300 MH	300 MH	1.20 HY	1.50 HY
—25	360 MH	360 MH	1.50 HY	1.75 HY
—26	430 MH	430 MH	1.75 HY	2.00 HY
—27	500 MH	500 MH	2.00 HY	2.40 HY
—28	600 MH	600 MH	2.40 HY	3.00 HY
—29	720 MH	720 MH	3.00 HY	3.60 HY
—30	860 MH	860 MH	3.60 HY	4.30 HY
—31	1.00 HY	1.00 HY	4.30 HY	5.00 HY
—32	1.20 HY	1.20 HY	5.00 HY	6.00 HY
—33	1.50 HY	1.50 HY	6.00 HY	7.20 HY
—34	1.75 HY	1.75 HY	7.20 HY	8.60 HY
—35	2.00 HY	2.00 HY	8.60 HY	10.0 HY
—36	2.40 HY	2.40 HY	10.0 HY	12.0 HY
—37	3.00 HY	3.00 HY	12.0 HY	15.0 HY
—38		3.60 HY	15.0 HY	17.5 HY
—39		4.30 HY	17.5 HY	20.0 HY
—40		5.00 HY	20.0 HY	24.0 HY
—41		6.00 HY	24.0 HY	30.0 HY
—42		7.20 HY	30.0 HY	36.0 HY
—43		8.60 HY	36.0 HY	43.0 HY
—44		10.0 HY		50.0 HY
—45		12.0 HY		60.0 HY
—46		15.0 HY		
—47		17.5 HY		

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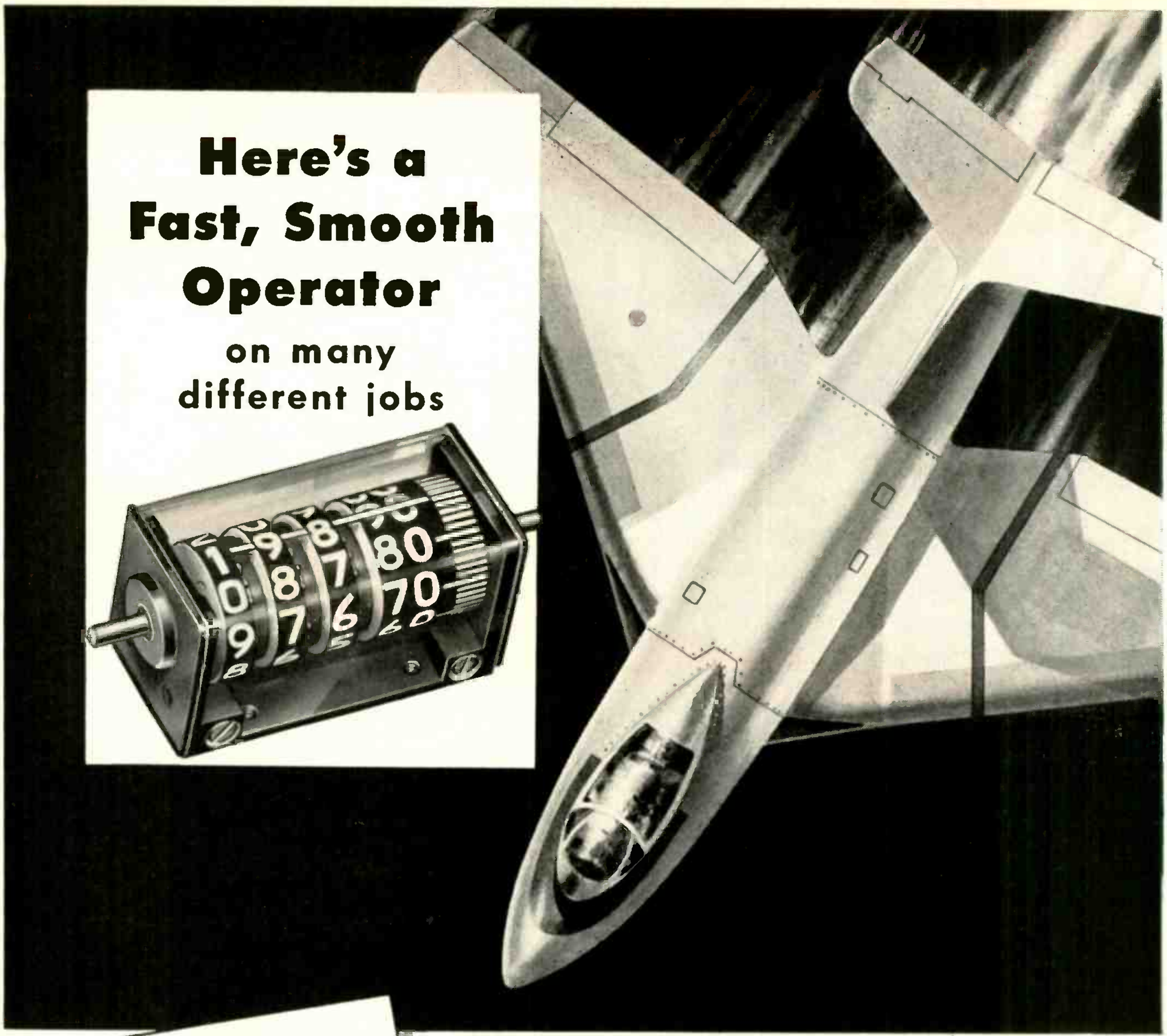

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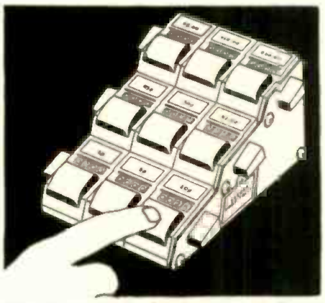

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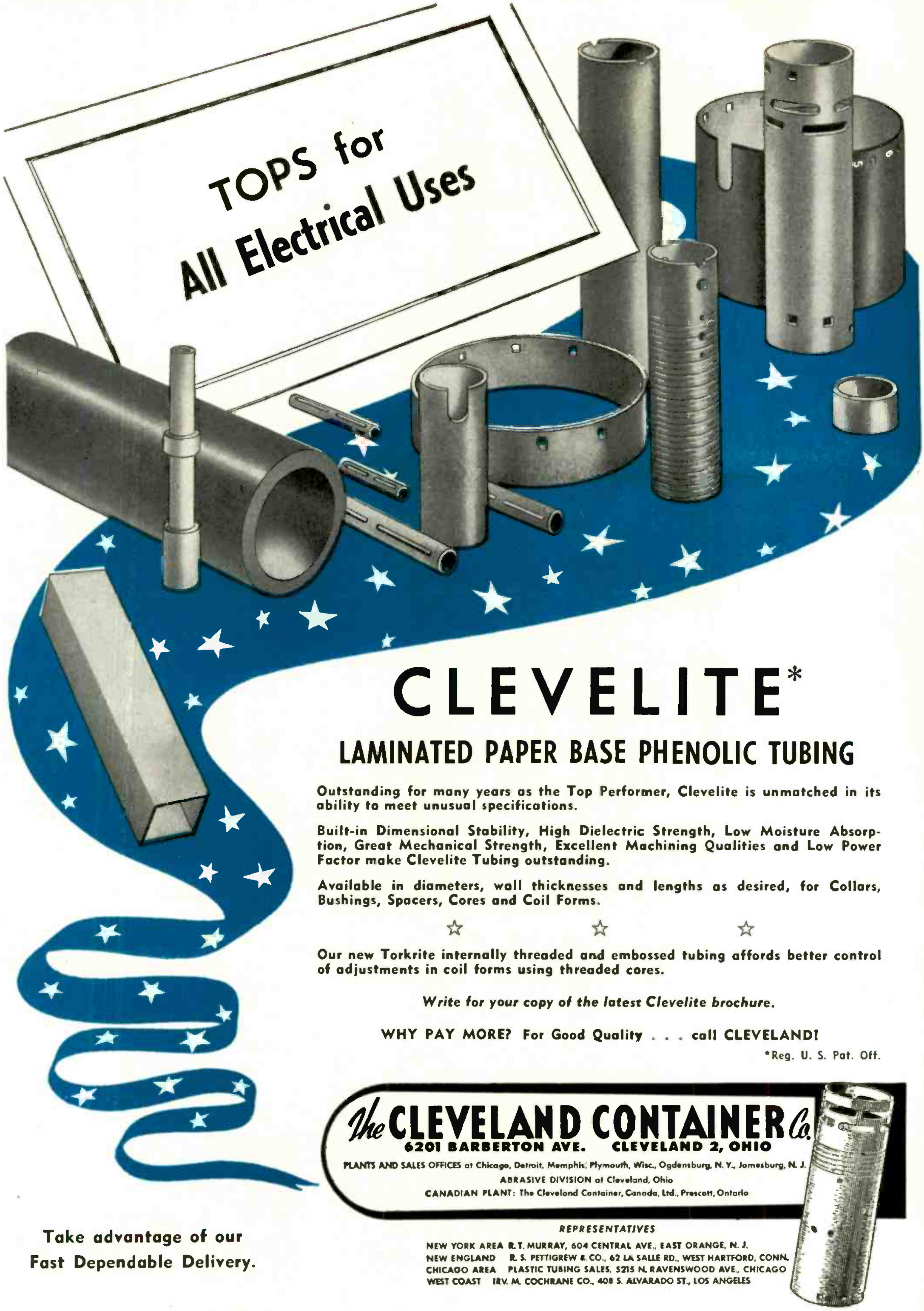

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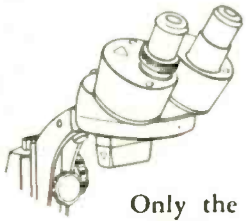

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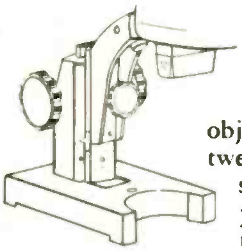

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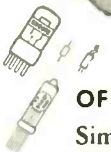

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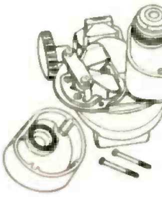

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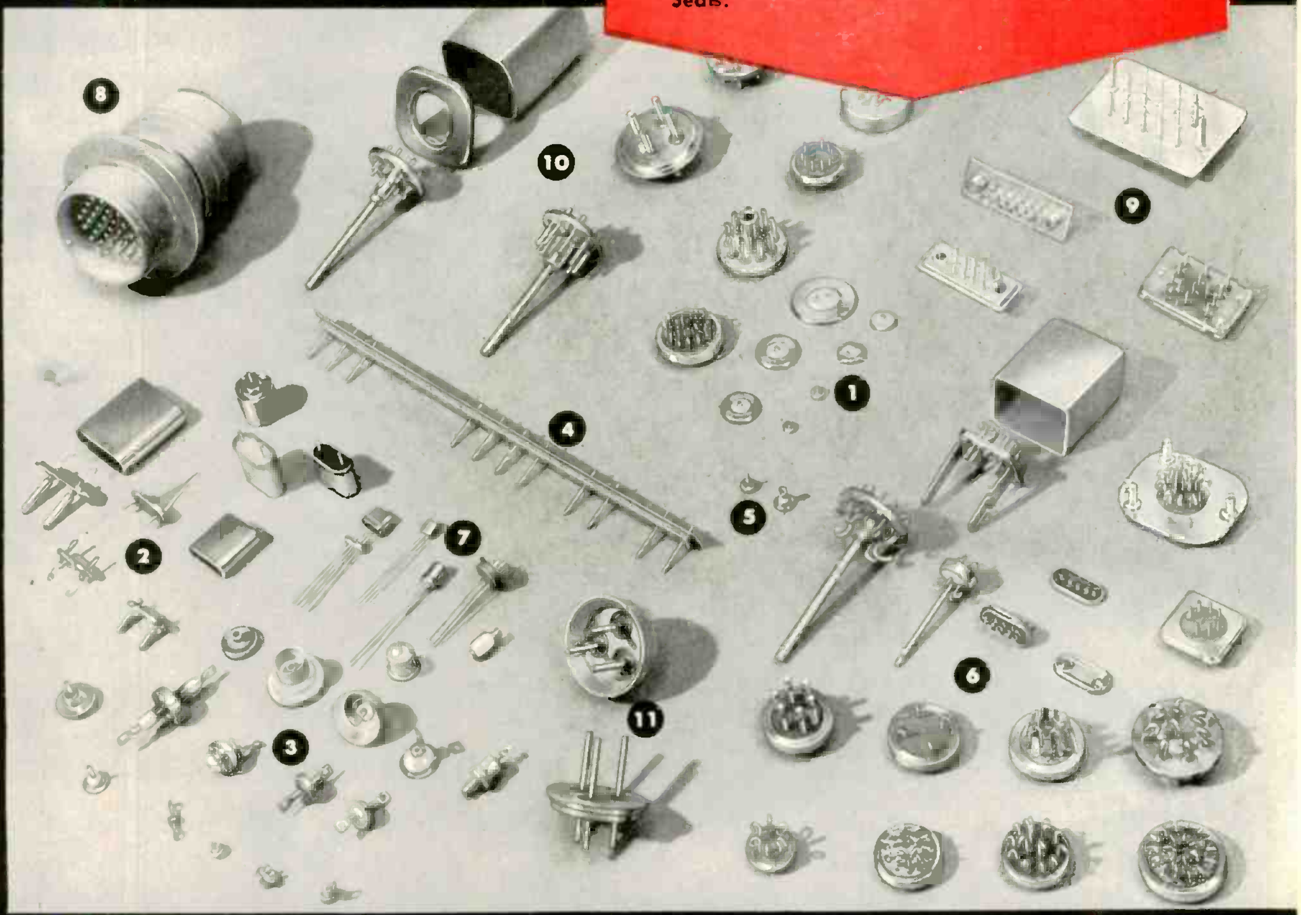

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- Per plate: gives 25 ma avg current, dissipates 4 w.
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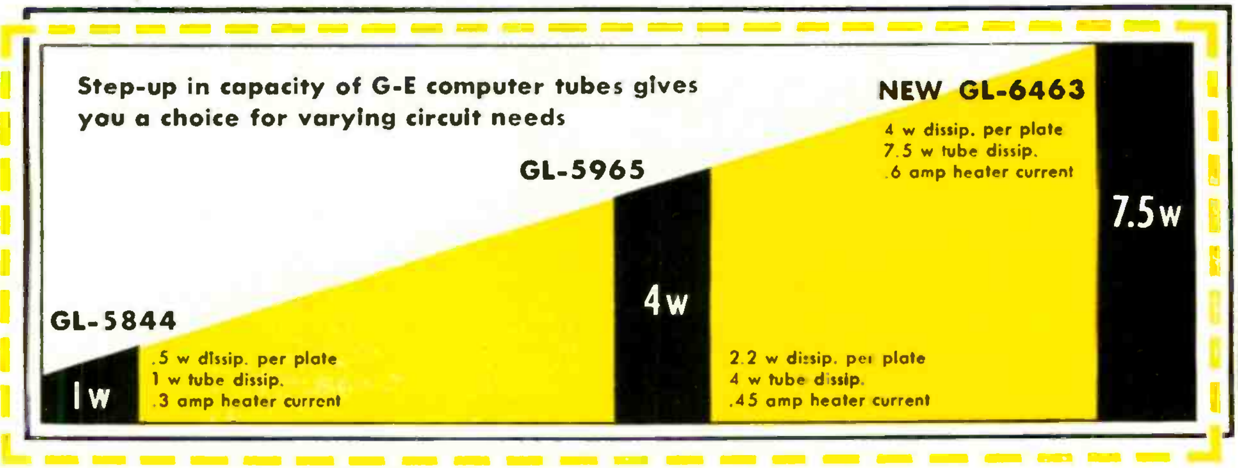
9-pin twin triode



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- Hermetically sealed oil filled condensers
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SPECIFICATIONS

INPUT .... 105-125 VAC, 50-60 C, 800 W (max)

DC OUTPUT NO. 1: (regulated for line and load)

Voltage	0-500 VDC (continuously variable)
Current	0-500 MA (over entire voltage range)
Regulation (line)	Better than 0.15% or 0.1 V
Regulation (load)	Better than 0.5% or 0.3 V
Internal Impedance	Less than 2 ohms
Ripple and Noise	Less than 8 millivolts rms
Polarity	Either positive or negative may be grounded

DC OUTPUT NO. 2: (regulated for line only)

Voltage Ranges	Internal Impedances:
a) 0-50 VDC (no load)	3,300 ohms (max)
b) 0-200 VDC (no load)	17,500 ohms (max)

Regulation (line)	Better than 0.1%
Ripple and Noise	Less than 5 millivolts rms

Polarity: Positive terminal connected internally to negative terminal of DC output No. 1

AC OUTPUTS (unregulated):

Two outputs, isolated and ungrounded. Each is 6.5 VAC at 5A (at 115 VAC input). Allows for drop in connecting leads. May be connected in series for 12.6 V (nominal) at 5A, or in parallel for 6.3 V (nominal) at 10A.

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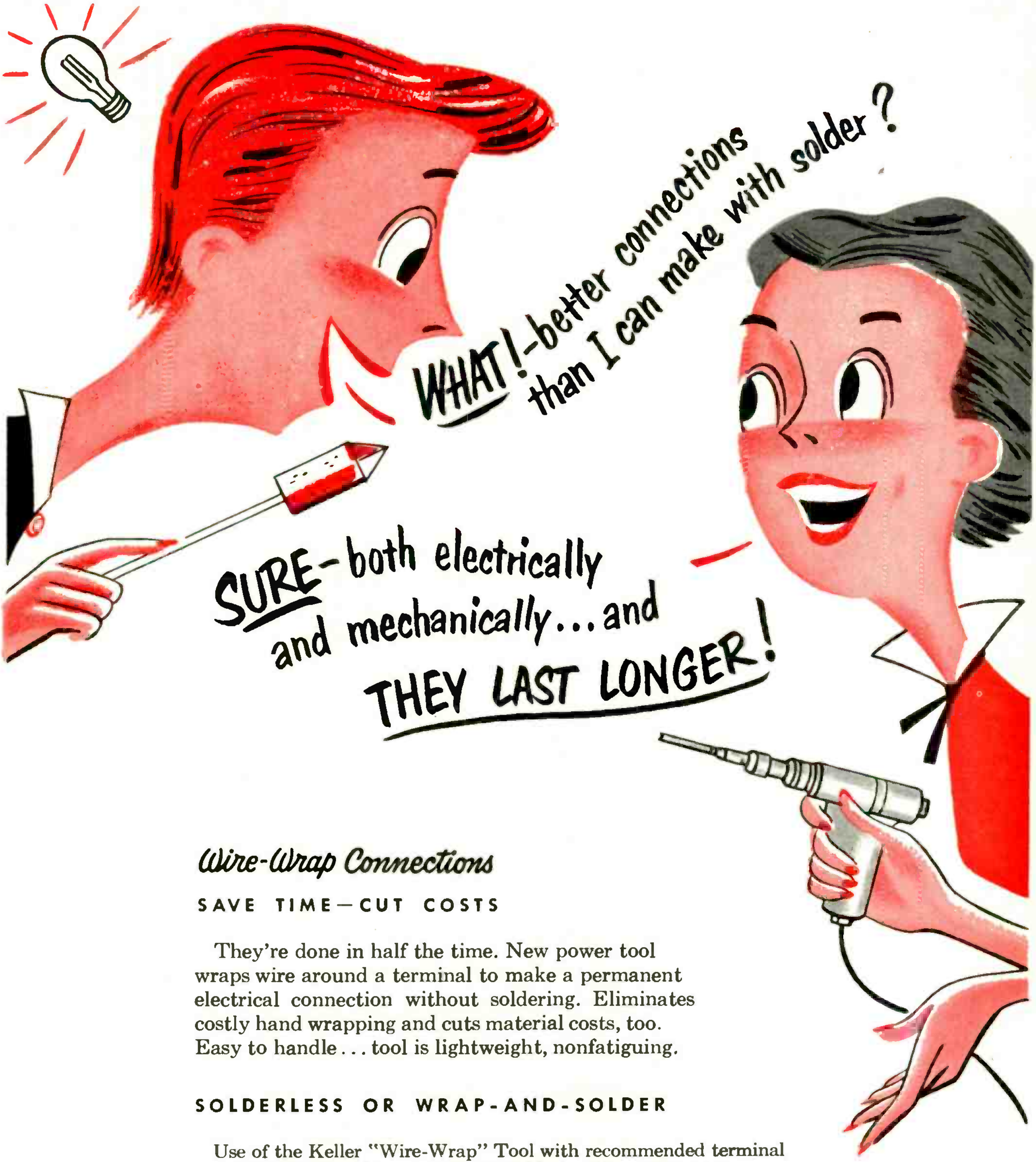
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They're done in half the time. New power tool wraps wire around a terminal to make a permanent electrical connection without soldering. Eliminates costly hand wrapping and cuts material costs, too. Easy to handle . . . tool is lightweight, nonfatiguing.

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PATENTED "F" CRIMP

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FOR WIRING

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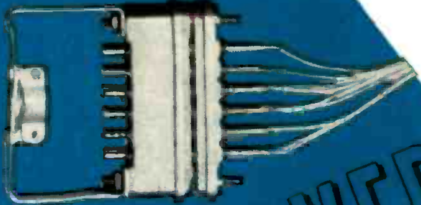
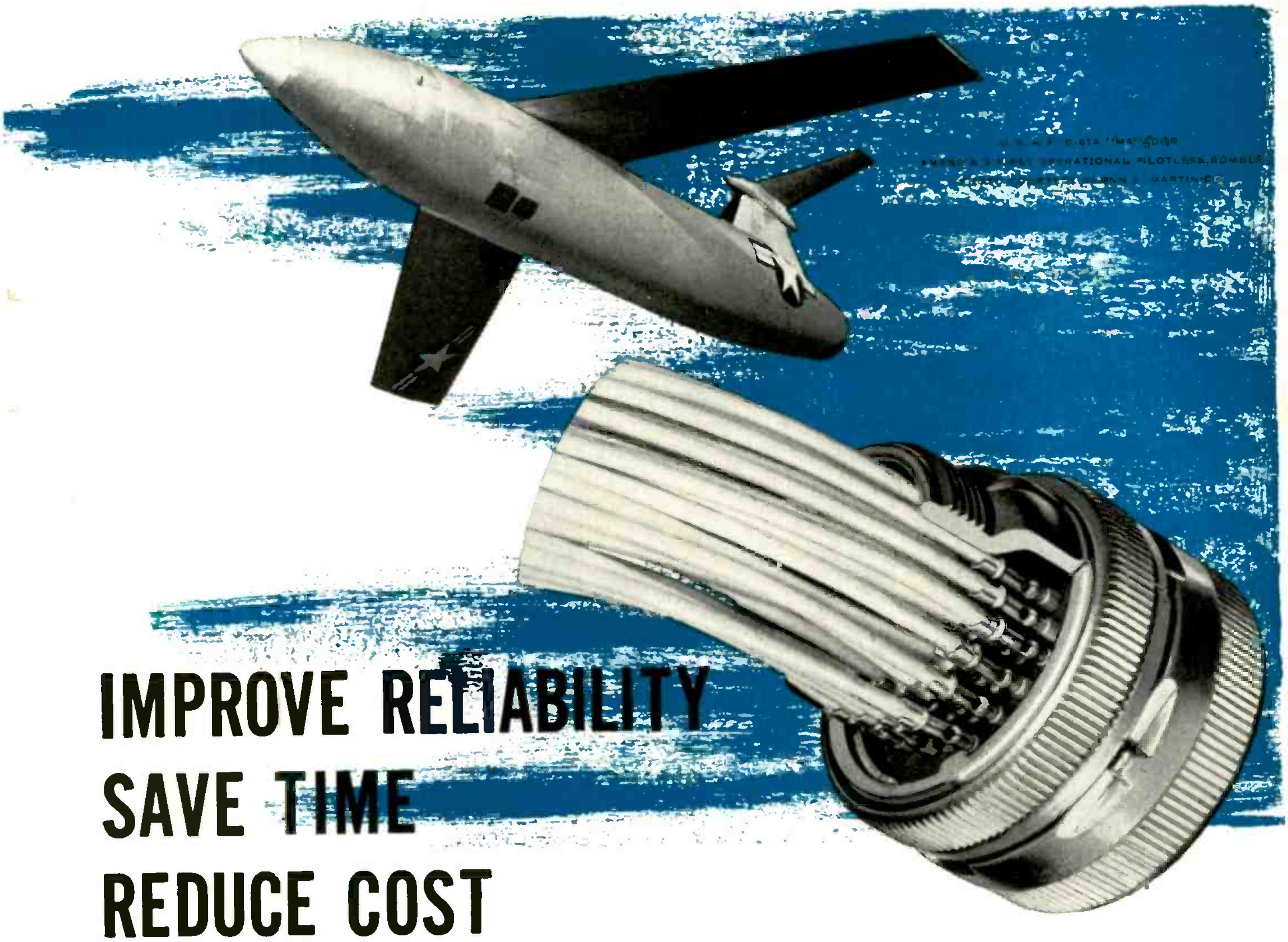
No solder, no flux, no solder pots or irons needed—just lock pin in tapered socket with AMP's "measured energy" CERTI-LOK insertion tool. Resulting connections are uniform and reliable—have extremely high contact pressure resulting in extremely low contact resistance.



AMP Taper Pins tested in AN type connectors exceed the applicable performance requirements of Military Specifications for AN connectors and solderless terminals. Taper Pin Connections are even more secure and show no change in contact resistance after vibration, temperature cycling, salt spray, and thermal shock tests. Copies of these test reports are available on request.

Find out about the New AMP "CREATIVE APPROACH TO BETTER WIRING"

. . . An evaluation survey without cost or obligation.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SAVE TIME
REDUCE COST

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For many years the Aircraft, Electronics and Communication industries have awaited this new and simpler method, since the soldering of wires to conventional AN connector contacts is a slow and painstaking process involving much skill and repeated inspection checks.

With AMP's new Taper Technique, a special AMP Patented "F" Crimp Taper Pin is attached to the wires by high speed automatic machines. This pin is then installed in the connector with one easy and positive stroke of AMP's new "measured energy" CERTI-LOK insertion tool. The result is uniformly better connections, produced in much less time with tremendous cost savings.

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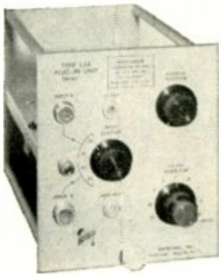
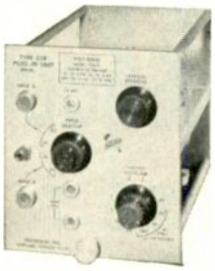
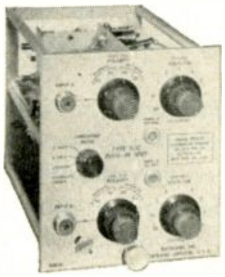


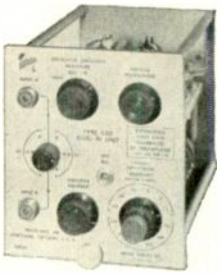
Type 53A Wide-Band DC Plug-In Preamplifier—dc to 10-mc passband, 0.035-µsec risetime. Sensitivity 0.05 v/cm to 50 v/cm, ac or dc, continuously variable, with nine calibrated steps from 0.05 v/cm to 20 v/cm. Two input connectors with 80-db isolation. Price $85.



Type 53B Wide-Band High-Gain Plug-In Preamplifier—same as the Type 53A with the addition of an ac-coupled input stage providing three additional calibrated sensitivity steps, 5 mv/cm, 10 mv/cm and 20 mv/cm. Passband 5 cycles to 9 mc, 0.04-µsec risetime. Two input connectors with 80-db isolation. Price $125.



Type 53C Dual-Trace Plug-In Preamplifier — two identical amplifier channels, each with dc to 8.5-mc passband, 0.04-µsec risetime, sensitivity 0.05 v/cm to 50 v/cm continuously variable with 9 calibrated steps from 0.05 v/cm to 20 v/cm. Electronic switching triggered by oscilloscope sweep, or free running at about 100 kc. Polarity reversal switches. Price $275.



Type 53D Differential High-Gain DC Plug-In Preamplifier—sensitivity 1 mv/cm at dc to 250 kc—with passband increasing to 750 kc at 50 mv/cm and lower. Sensitivity in calibrated steps—1 mv/cm to 50 v/cm, or continuously variable—1 mv/cm to 125 v/cm. Differential input. Price $145.

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She keeps Case History Records of *every* Stackpole iron core ever made!

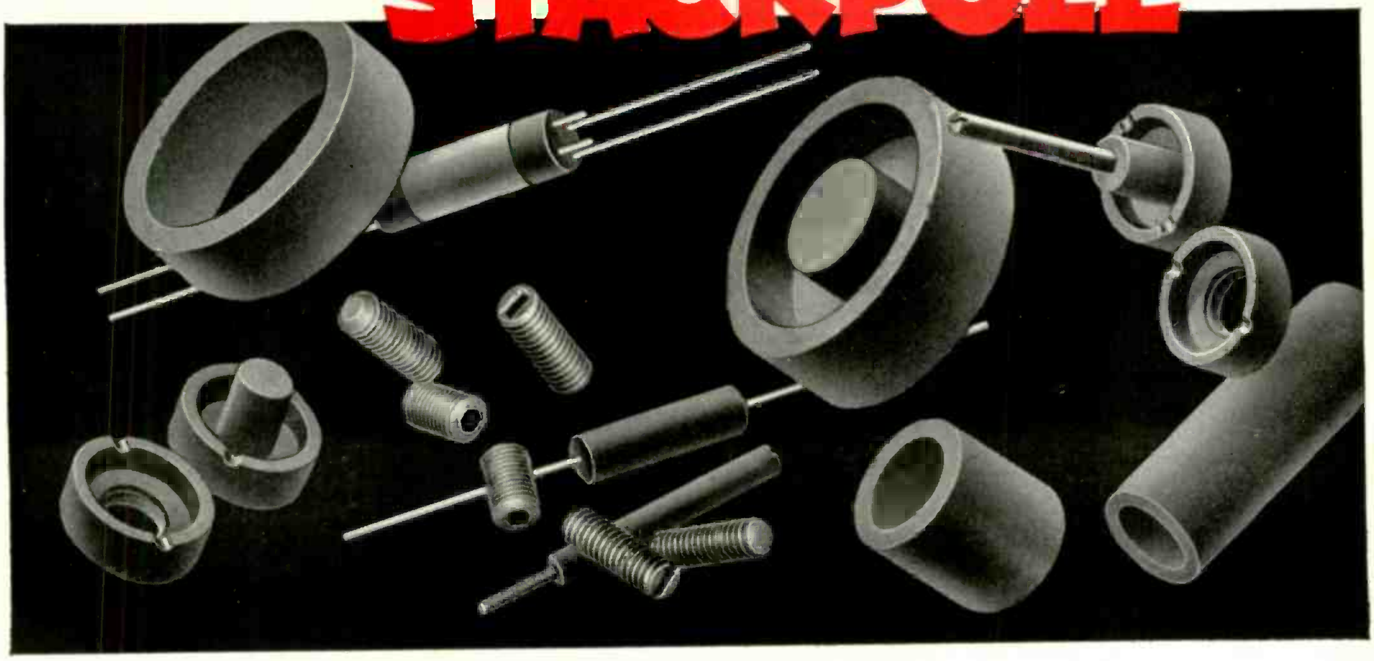
Producing iron cores that are really uniform, or matching a new batch of cores to the exact specifications of a previous run are critical jobs!

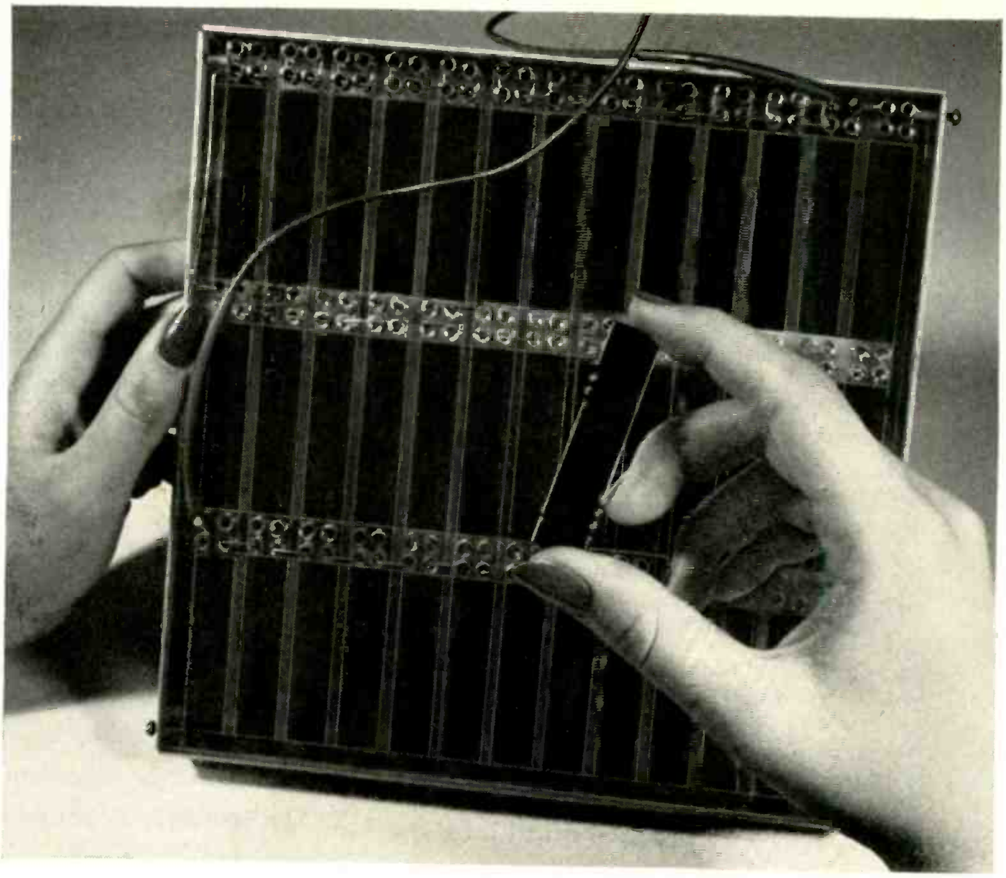
That's why the files from which the above sketch was made are basic in assuring Stackpole iron core superiority in these all-important respects. For here are kept careful *formula records and production case histories of every Stackpole iron core ever made.*

Guesswork goes out the window. These files backed by over a quarter of a century's experience in molding top quality components from metal powders mean that each and every Stackpole core is exactly as you want it . . . electrically as well as mechanically. *And each one made to a given specification is exactly like the others.*

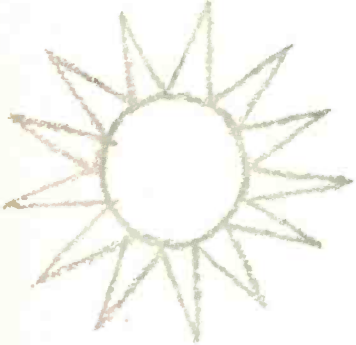
Electronic Components Division
STACKPOLE CARBON COMPANY,
St. Marys, Pa.

STACKPOLE





The Bell Solar Battery. A square yard of the small silicon wafers turns sunshine into 50 watts of electricity. The battery's 6% efficiency approaches that of gasoline and steam engines and will be increased. Theoretically the battery will never wear out. It is still in the early experimental stage.



Bell Solar Battery

Bell Laboratories scientists have created the Bell Solar Battery. It marks a big step forward in converting the sun's energy directly and efficiently into usable amounts of electricity. It is made of highly purified silicon, which comes from sand, one of the commonest materials on earth.

The battery grew out of the same long-range research at Bell Laboratories that created the transistor—a pea-sized amplifier originally made of the semiconductor germanium. Research into semiconductors pointed to silicon as a solar energy converter. Transistor-inspired techniques developed a silicon wafer with unique properties.

The silicon wafers can turn sunlight into electricity to operate low-power mobile telephones, and charge storage batteries in remote places for rural telephone service. These are but two of the many applications foreseen for telephony.

Thus, again fundamental research at Bell Telephone Laboratories paves the way for still better low-cost telephone service.

Inventors of the Bell Solar Battery, left to right, G. L. Pearson, D. M. Chapin and C. S. Fuller – checking silicon wafers on which a layer of boron less than 1/10,000 of an inch thick has been deposited. The boron forms a "p-n junction" in the silicon. Action of light on junction excites current flow.

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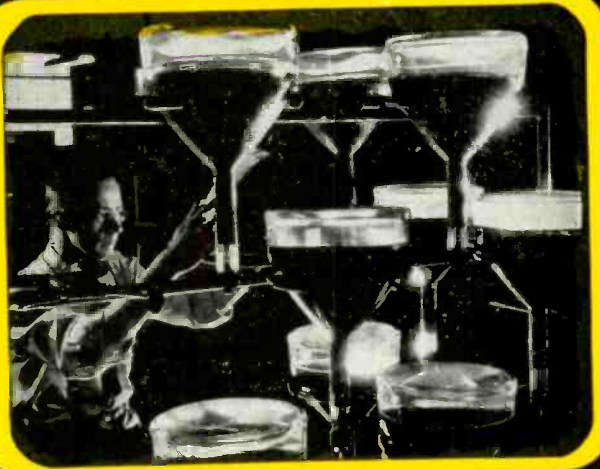

'dag' Exterior Wall Coating is a dispersion of extremely fine graphite in lacquer.

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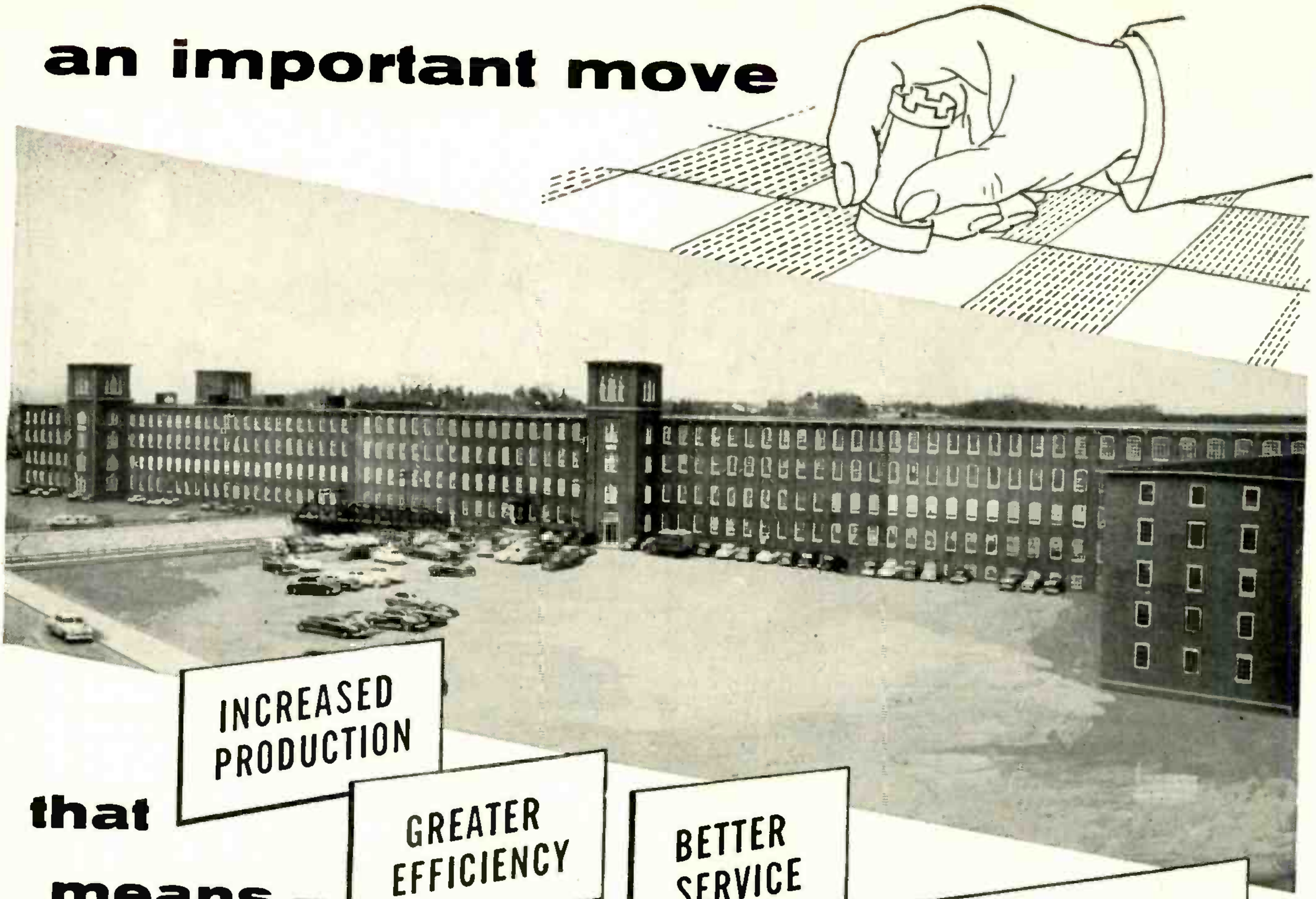

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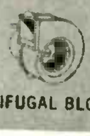

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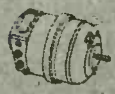

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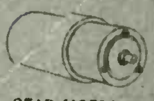

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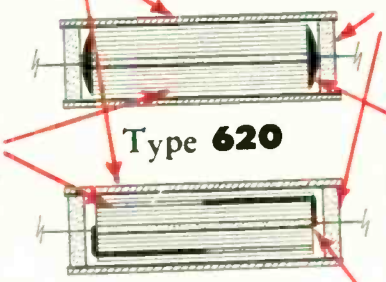
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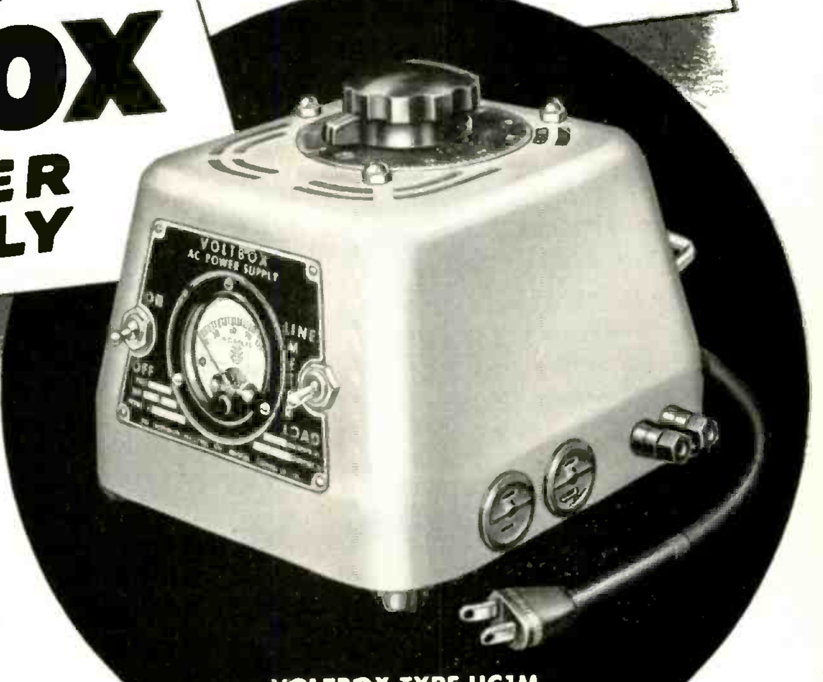

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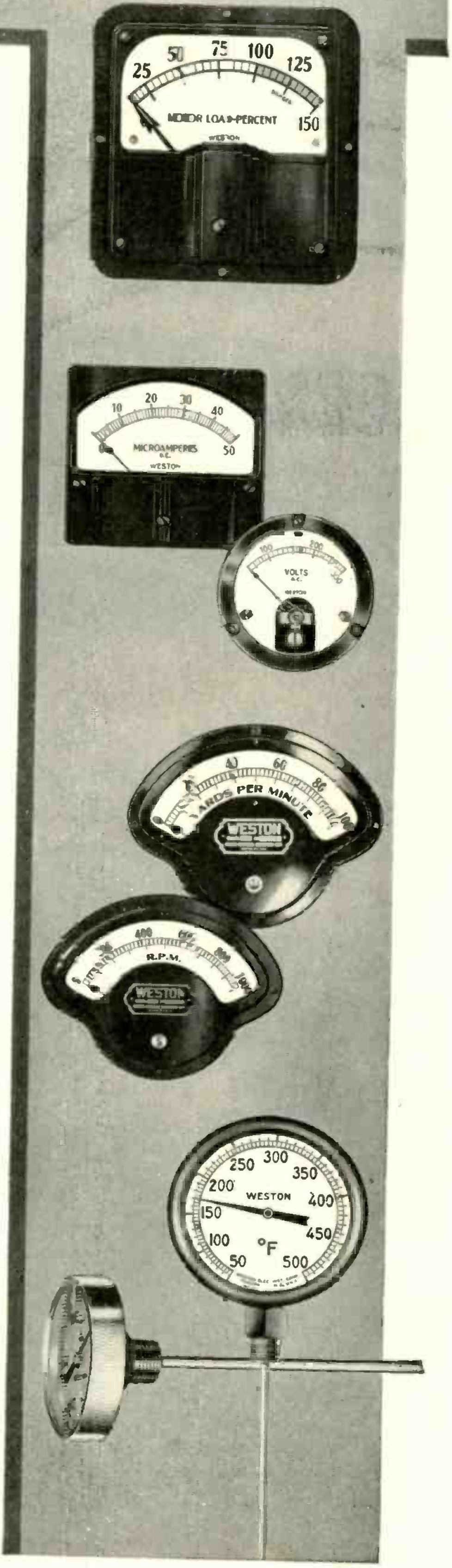

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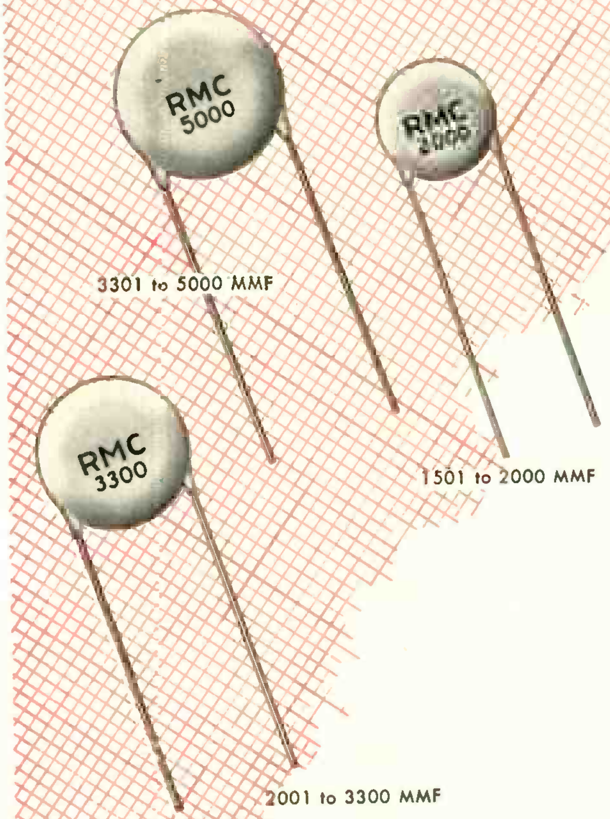

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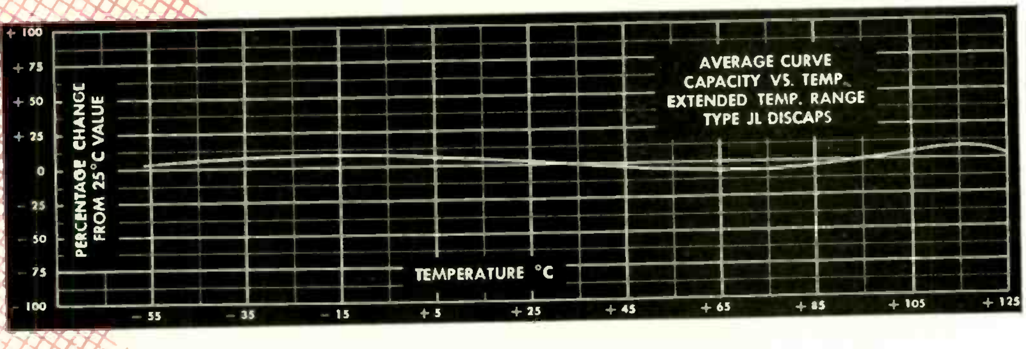

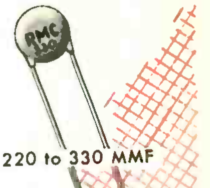

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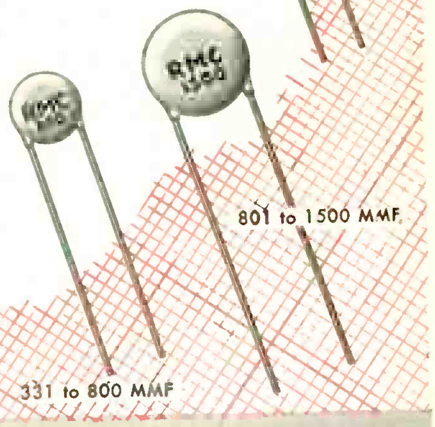

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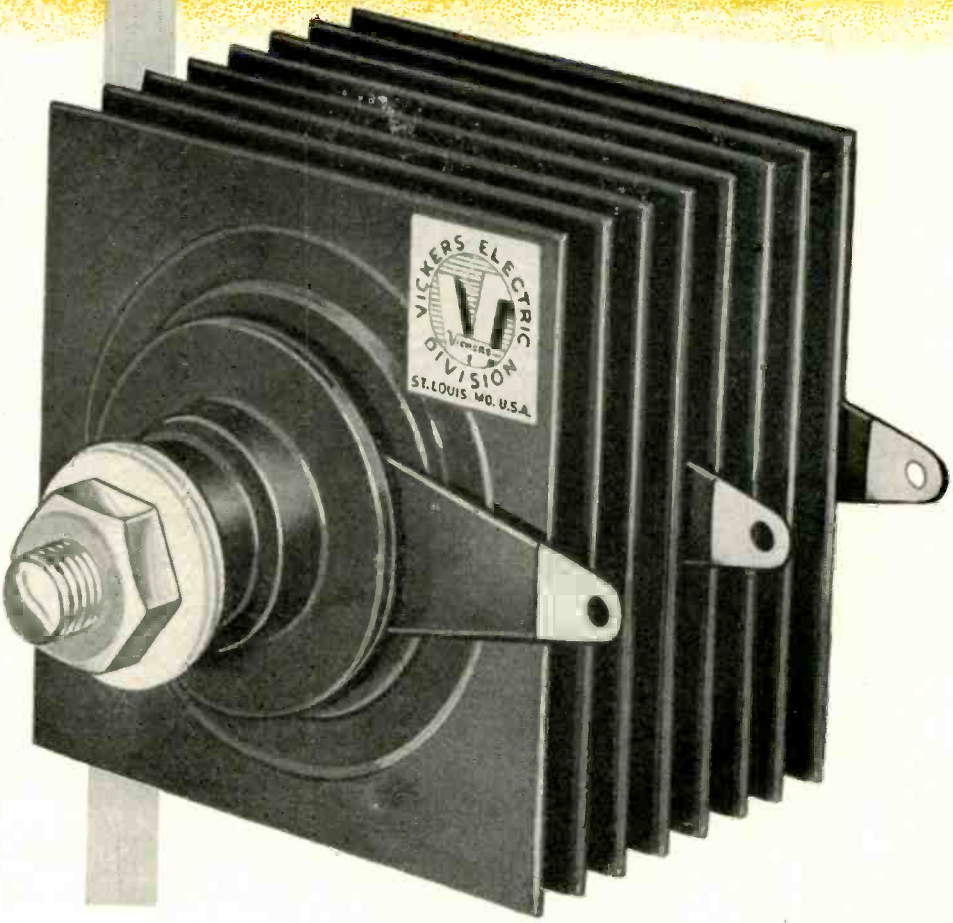
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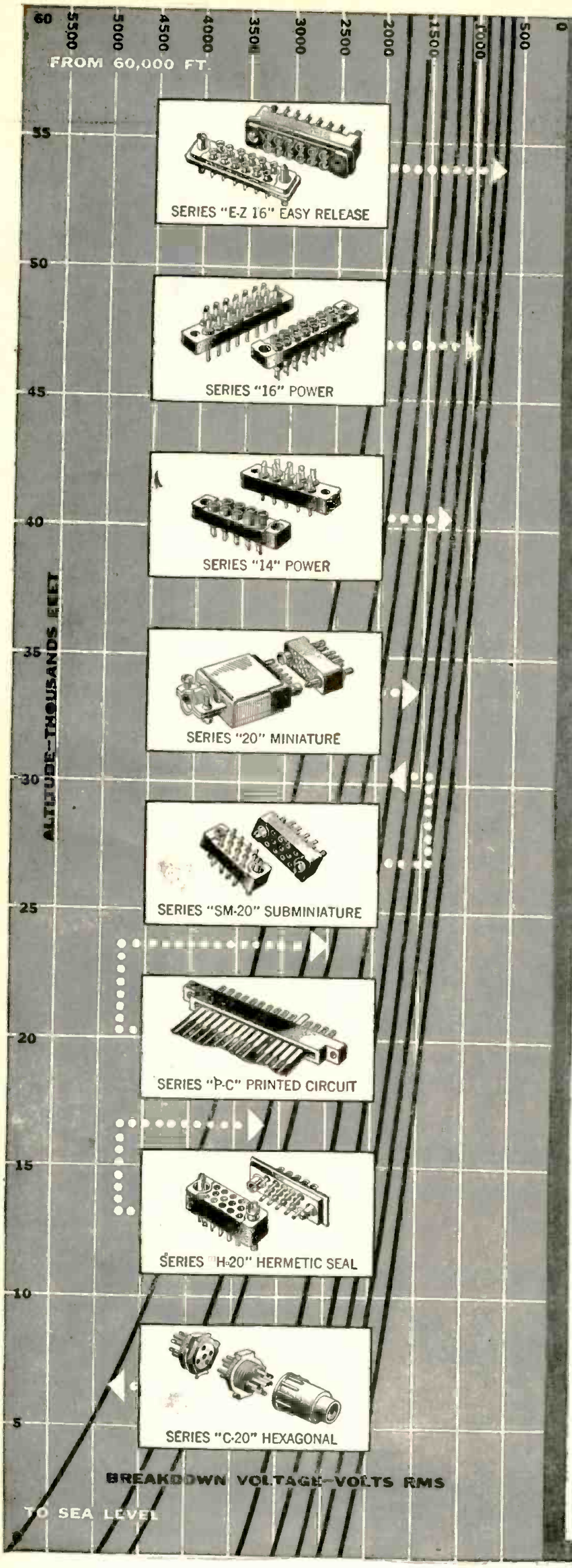

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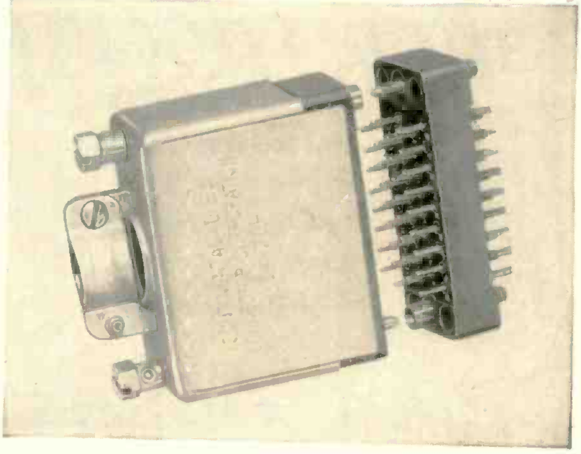

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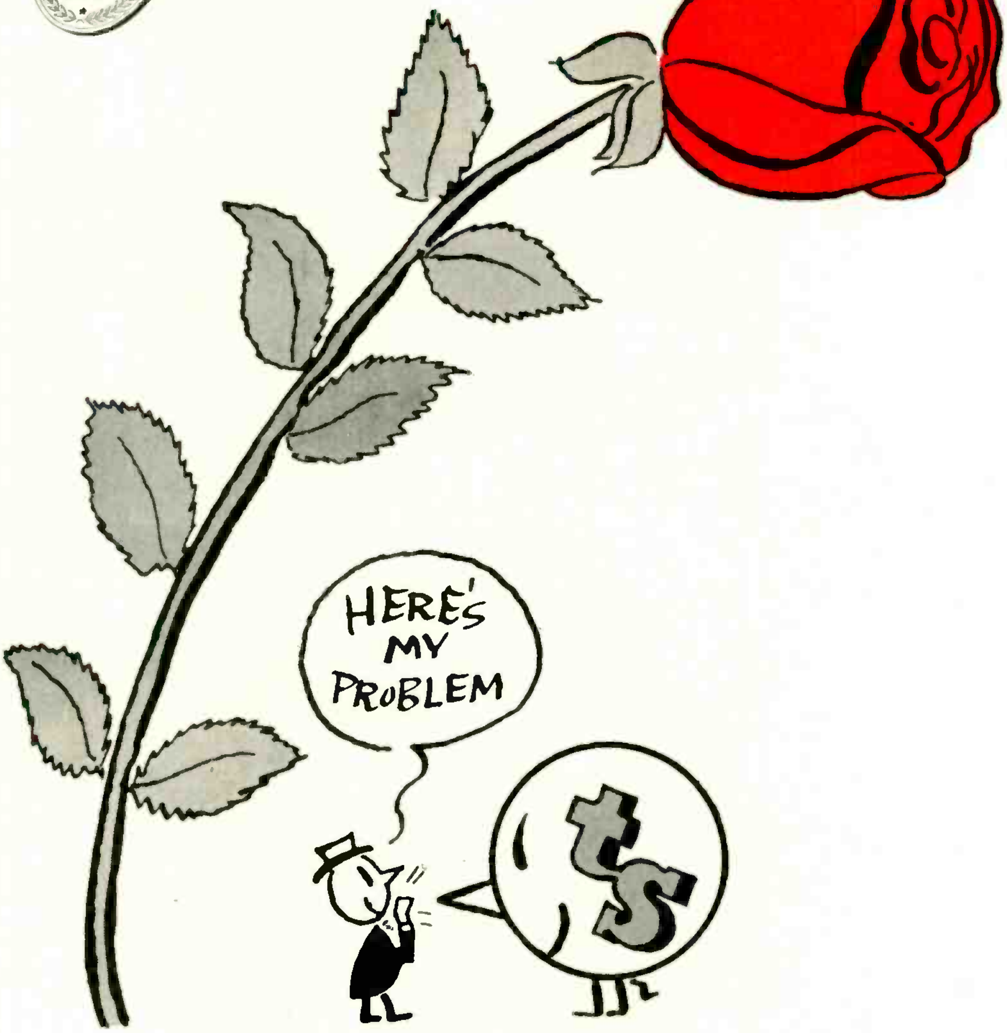

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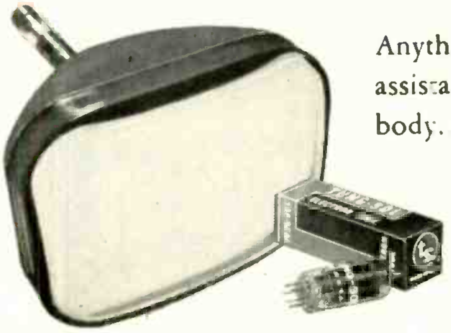

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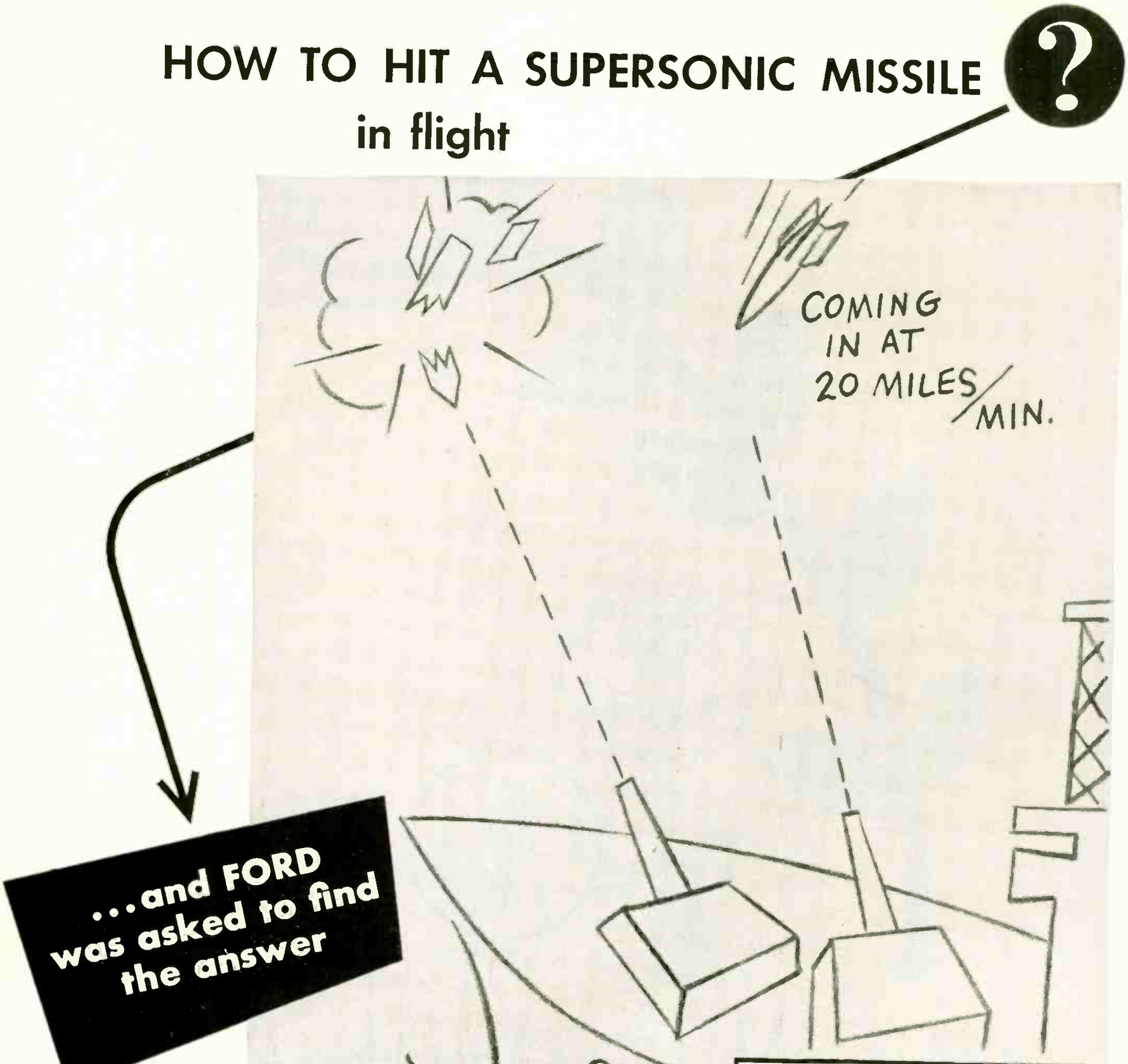
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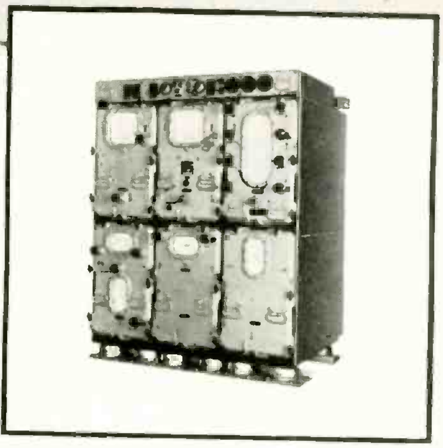

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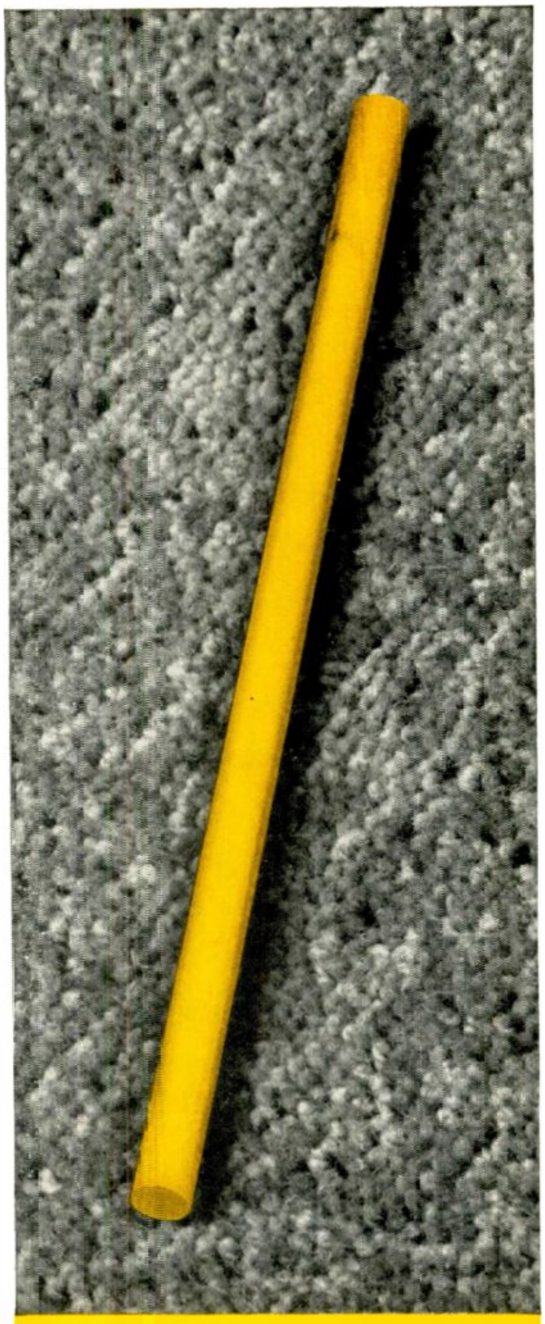

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Arc resistance	120 sec.
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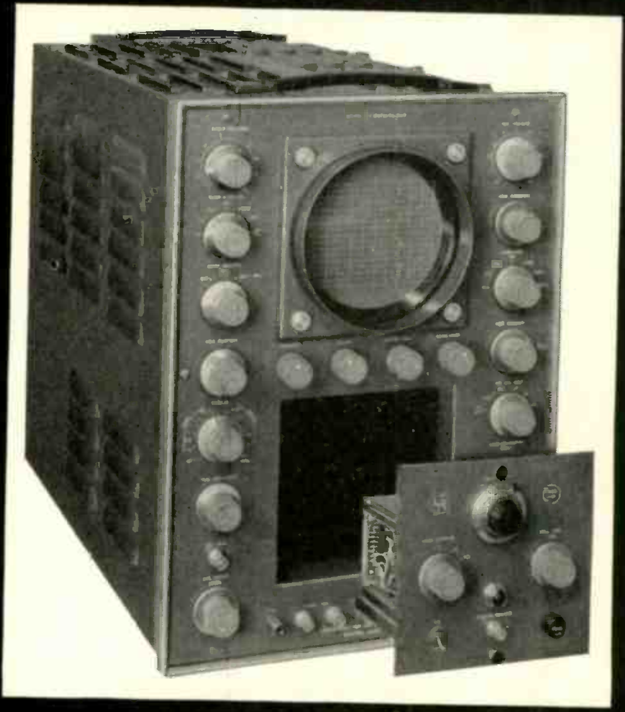
Deflection Plates Accessible.
Power Requirements: 105-125 V., or 210-250 V., 50-60 cycles, 385 watts.
Dimensions: 13" w, 17¾" h, 21" d.



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75 Pitts Street Boston 14, Mass.

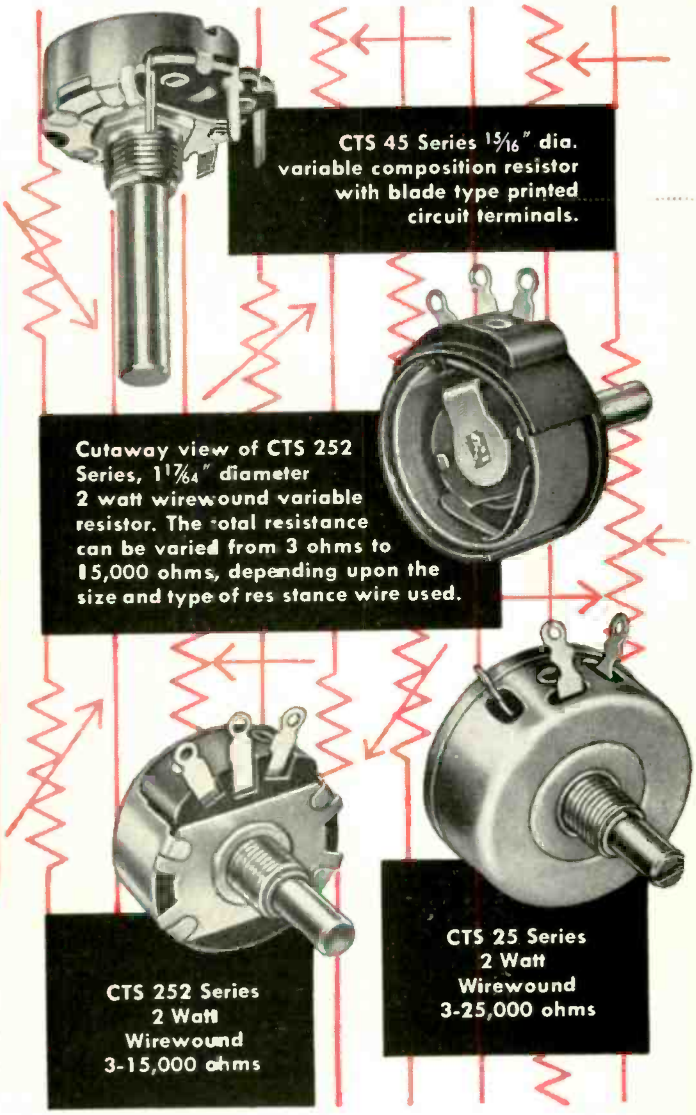
**OSCILLOSCOPES • MAGNETOMETERS • COMPUTERS
SOLID DELAY LINES • SPAR • SPAR-S**

"DRIVER-HARRIS ALLOYS

have contributed greatly in making our performance possible"

says

CHICAGO TELEPHONE SUPPLY *Corporation*



CTS 45 Series 1⁵⁄₁₆" dia. variable composition resistor with blade type printed circuit terminals.

Cutaway view of CTS 252 Series, 1¹⁷⁄₆₄" diameter 2 watt wirewound variable resistor. The total resistance can be varied from 3 ohms to 15,000 ohms, depending upon the size and type of resistance wire used.

CTS 252 Series
2 Watt
Wirewound
3-15,000 ohms

CTS 25 Series
2 Watt
Wirewound
3-25,000 ohms

Chicago Telephone Supply Corporation has succeeded in accomplishing two things indeed difficult to combine, as summed up in their slogan "Specialists in Precision Mass Production of Variable Resistors." They manufacture the high quality variable resistors indispensable to radio, television, and military electronics. In fact, they are the world's largest producers of variable resistors.

To achieve this outstanding record, they concentrate their entire effort on variable resistors, they maintain close control over all manufacturing processes, and fabricate their own parts under close supervision from basic raw materials. Naturally, they make no secret of the importance to them of high quality materials.

States Chicago Telephone: "To make our raw material program effective, we have stressed the importance of dependable, quality-minded sources of supply. Driver-Harris is a supplier with these qualities, *and Driver-Harris alloys have contributed greatly in making our performance possible.* For many years we have been using Driver-Harris Nichrome*, Karma*, Advance*, and other D-H Alloy wires for our resistance windings, with excellent results. We can strongly endorse Driver-Harris' dependability and high quality products."

Nichrome, Advance, and Karma are at your service too, as are more than 80 other D-H alloys developed for application in the electrical and electronic fields. If a high degree of resistance and absolute uniformity of output are "musts" for *your* product, let us have your specifications. We'll be glad to make recommendations based on your specific requirements.

*T.M. Reg. U.S. Pat. Off.

Sole producers of Nichrome, Advance, Karma

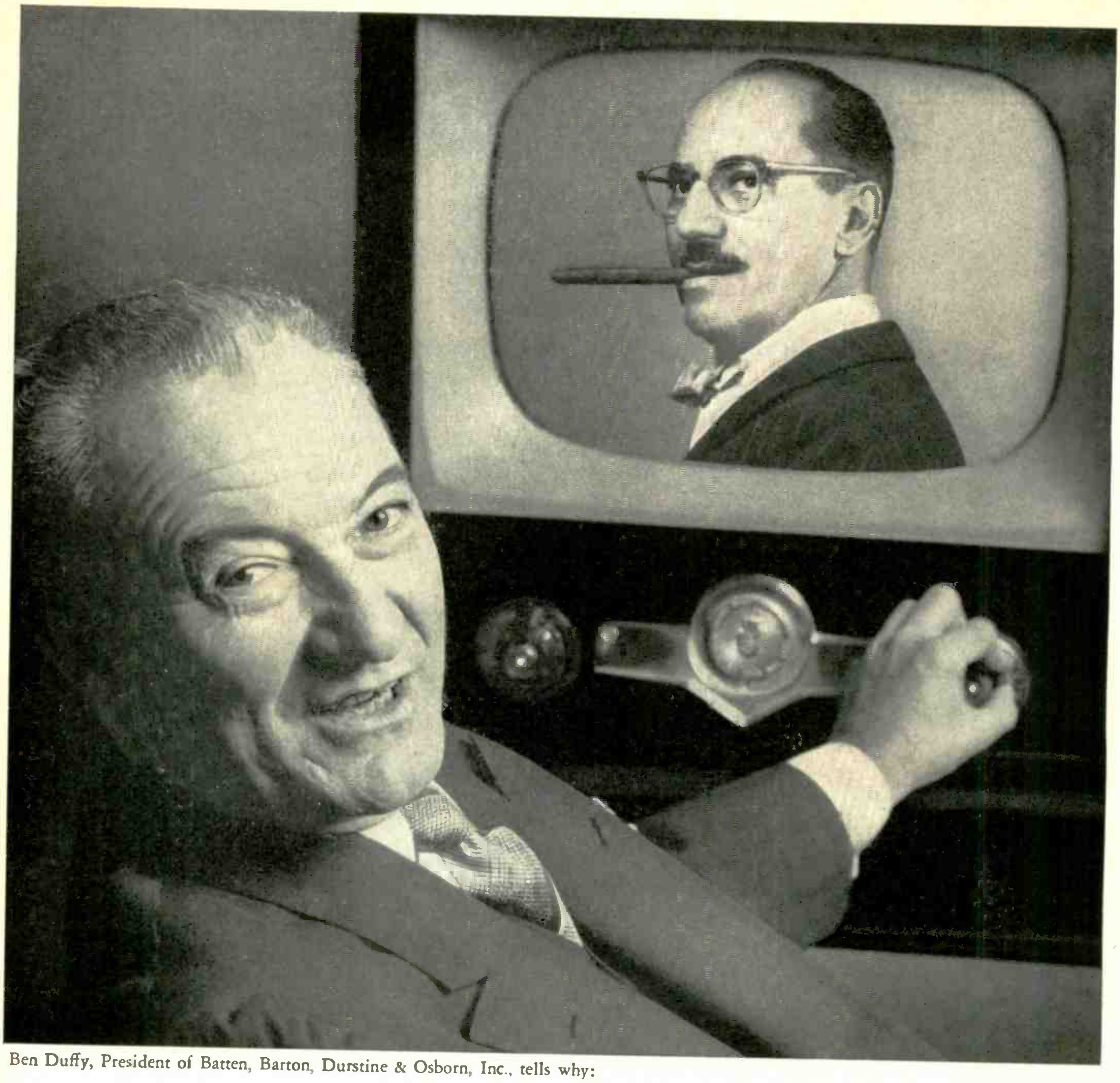
Driver-Harris Company

HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Louisville, Los Angeles, San Francisco

In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario.

MAKERS OF THE MOST COMPLETE LINE OF ELECTRIC HEATING, RESISTANCE, AND ELECTRONIC ALLOYS IN THE WORLD



Ben Duffy, President of Batten, Barton, Durstine & Osborn, Inc., tells why:

"You don't have to wait for Groucho!"

"Snap on your TV set Thursday night—there's Groucho," Ben Duffy points out, "and he never fails to be there.

"You—and BBDO—can thank Air Express for that. It's Air Express that carries Groucho's films regularly.

"TV films are always due at a certain hour, often the whole way across the country. The same with printing plates. They may have to reach 100 different cities to make a specific edition of many publications.

"Air Express gets these essential materials there—every day in the year. It's the most reliable service we know.

"Frequently, we send duplicate shipments in case one should be marred or lost in handling—but this precaution has never once been necessary.

"Important, too, is the fact that almost all our shipments—more than 1,000 a year—cost us less with Air Express than with other air services."

It pays to express yourself clearly. Say Air Express! Division of Railway Express Agency.

AIR EXPRESS **Air Express**

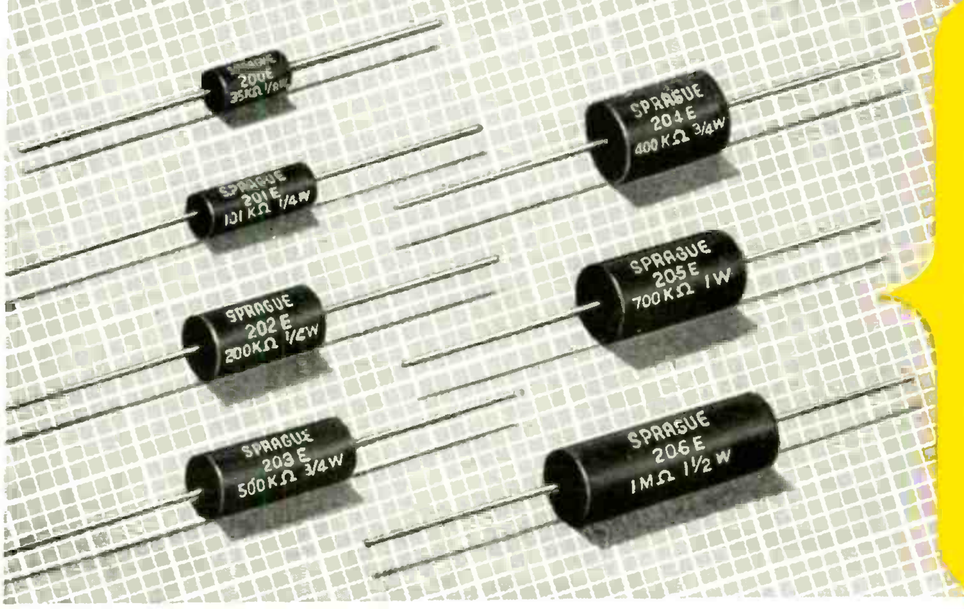
GETS THERE FIRST *via U.S. Scheduled Airlines*

CALL AIR EXPRESS . . . *division of* RAILWAY EXPRESS AGENCY

PERMASEAL®

PRECISION RESISTORS

NOW! ENCAPSULATED AXIAL LEAD STYLES FOR 85°C, 125°C and 150° AMBIENTS



85°C PERMASEAL® RESISTORS

SPRAGUE TYPE	SIZE D	SIZE L	SIZE LEADS	RATED WATTS	MAX. OHMS
200E	¼	½	No. 22 AWG	.20	140,000
201E	¼	¾	No. 22 AWG	.33	225,000
202E	⅜	¾	No. 20 AWG	.50	500,000
203E	⅜	1	No. 20 AWG	.75	700,000
204E	½	¾	No. 20 AWG	.75	1.2 MΩ
205E	½	1	No. 20 AWG	1.00	1.7 MΩ
206E	½	1½	No. 20 AWG	1.50	2.8 MΩ

125°C PERMASEAL® RESISTORS

SPRAGUE TYPE	SIZE D	SIZE L	SIZE LEADS	RATED WATTS	MAX. OHMS
300E	¼	½	No. 22 AWG	.10	140,000
301E	¼	¾	No. 22 AWG	.15	225,000
302E	⅜	¾	No. 20 AWG	.25	500,000
303E	⅜	1	No. 20 AWG	.30	700,000
304E	½	¾	No. 20 AWG	.30	1.2 MΩ
305E	½	1	No. 20 AWG	.40	1.7 MΩ
306E	½	1½	No. 20 AWG	.60	2.8 MΩ

PERMASEAL accurate wire-wound resistors are ideal for point-to-point wiring, for terminal board mounting and for use on processed wiring chassis.

Encapsulated for protection against high humidity, these resistors will stand up in military and industrial electronic service. The protective housing also guards against physical damage during installation and during equipment maintenance.

Standard designs are available in seven different physical sizes for operation at full rated wattage at ambient temperatures of 85°C and 125°C. Special units can be made for operation at 150°C ambient with full rated wattage dissipation.

Unusual long-term stability of resistance is another plus feature of Sprague Permaseal Resistors—as the result of careful matching of winding forms, resistance wire and encapsulating material—together with a thoroughly controlled aging process during manufacture. Permaseal Resistors are available in resistance tolerances down to 0.1%, when necessary.

SPRAGUE Engineering Bulletin
PERMASEAL RESISTORS

SPRAGUE

FOR COMPLETE DATA, WRITE FOR COPY OF SPRAGUE ENGINEERING BULLETIN NO. 122, WITHOUT DELAY.

SPRAGUE ELECTRIC COMPANY,
35 Marshall Street, North Adams, Mass.

PIONEERS IN ELECTRIC AND ELECTRONIC DEVELOPMENT

NORTH ADAMS, MASSACHUSETTS

EXPORT FOR THE AMERICAS: SPRAGUE ELECTRIC INTERNATIONAL LTD., NORTH ADAMS, MASS. CABLE: SPREXINT

Completely Self-contained Miniature

FREQUENCY STANDARD

WITH EXCEPTIONAL ACCURACY

2007
AMERICAN TIME PRODS. INC.
NEW YORK, N.Y.
LICENSED UNDER U.S. PATENTS OF
WESTERN ELECTRIC CO.

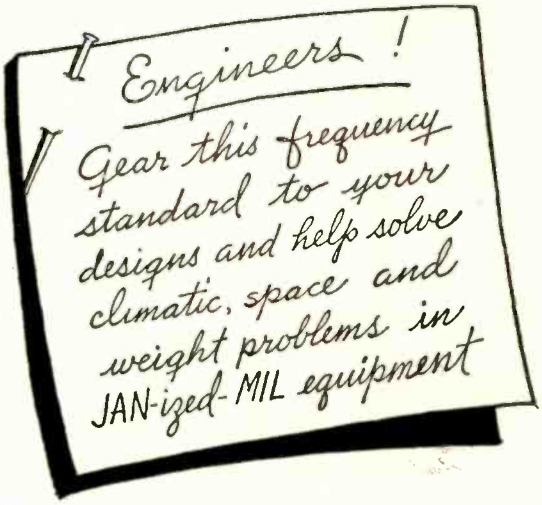
ACTUAL
SIZE

A compact, complete, hermetically sealed frequency standard, presenting these features:—

1. JAN-ized construction throughout.
2. SPACE-SAVING, 1½" dia. x 4½" high.
3. WEIGHT, approximately 10 ounces.
4. AVAILABLE in 400 and 500 cycles.
5. ACCURACY—.002% (15° to 35°C).
6. SHOCK-MOUNTED on Silicone rubber.
7. POWER REQUIRED, 6 V. at 300 ma. 70 to 200 V. at 1 to 5 ma.

WRITE FOR DESCRIPTIVE LITERATURE,
SPECIFYING "TYPE 2007"

Also, manufacturers of frequency standards, multi-frequency standards, chart-recording chronographs, firing-cycle timers, the Watch-Master Watch Rate Recorder and other high-precision frequency and timing instruments, controlled by our tuning-fork oscillators.



Engineers!

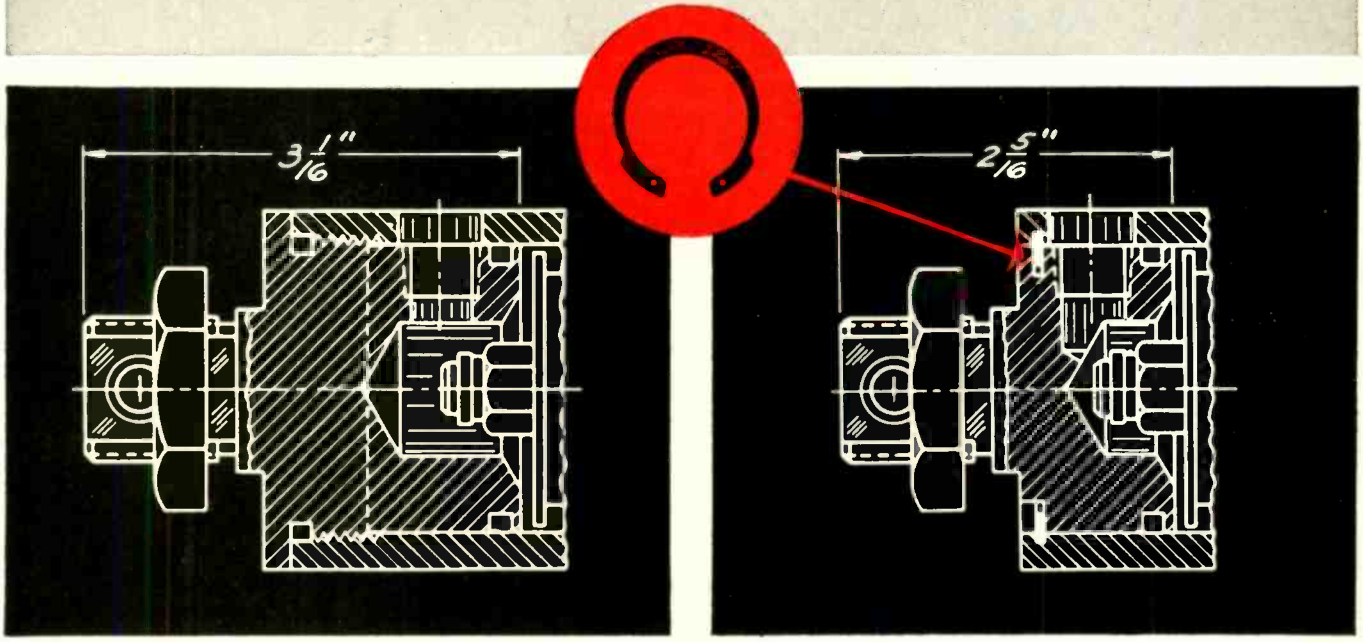
Gear this frequency standard to your designs and help solve climatic, space and weight problems in JAN-ized-MIL equipment

American Time Products, Inc.

580 Fifth Avenue **New York 36, N. Y.**

MANUFACTURING UNDER PATENTS OF THE WESTERN ELECTRIC COMPANY

Waldes Truarc Rings Cut Costs $3.26 per Unit, Reduce Size and Weight of Air Cylinder!



OLD STYLE air cylinder, with thread-secured head, required costly tapping, chasing and assembly operations. Also, satisfactory maintenance of packing unit necessitated use of pipe wrenches on painted surfaces.

NEW cylinder head is secured with precision-ground Waldes Truarc Rings. This produces perfect alignment of head within the housing, difficult to obtain with screw-thread seating. Maintenance is quick and easy.

WALDES TRUARC RINGS PERMITTED THESE SAVINGS

Production Time Cut..17 minutes
Weight Saved..................1¾ lb.
Length Shortened........1½ inches
Cost Saved..................$3.26 unit

■ The A. K. Allen Company of Brooklyn, New York, maker of *AllenAir* cylinders, now uses two Waldes Truarc Inverted Rings (series 5008) to secure heads rigidly within tubes.

■ TRUARC Rings, in this application, are ground parallel by A. K. Allen to .001 tolerance. In a static hydraulic bursting test, the 3" unit (recommended for 350 p.s.i.) withstands a pressure of 2000 p.s.i. And at bursting-point, the brass groove gives way; the Truarc Ring remains intact.

■ Waldes Truarc Retaining Rings are precision-engineered . . . quick and easy to assemble and to disassemble. They can be used over and over again. There's a Waldes Truarc Ring to answer every fastening problem.

■ Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc engineers.

For precision internal grooving and undercutting . . . Waldes Truarc Grooving Tool

SEND FOR NEW CATALOG

WALDES
TRUARC
REG. U. S. PAT. OFF.
RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,509,081; AND OTHER PATENTS PENDING.

E076

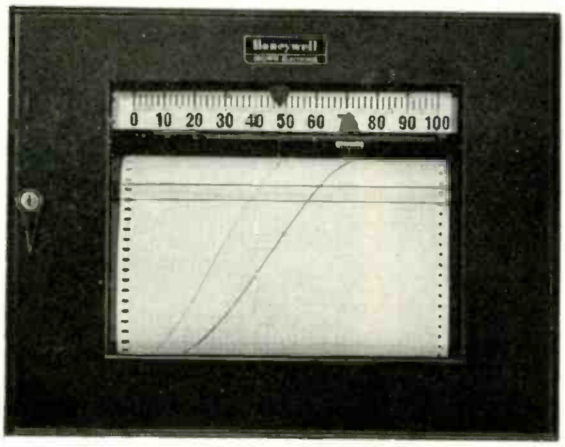
Waldes Kohinoor, Inc., 47-16 Austel Pl., L. I. C. 1, N. Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

(Please print)

Name..
Title..
Company..
Business Address..
City.............................. *Zone*.......... *State*..............

Automatically plots two variables as a function of a third---



the *ElectroniK*

Duplex Function Plotter

NEWEST of the many modifications of the *ElectroniK* recorder, especially designed for research work, is the Duplex Function Plotter. A two-pen version of the now famous Function Plotter, this instrument has three independent measuring systems; one for each of the horizontally moving pens, and one coupled to the vertically moving chart. The instrument is thus able to draw two simultaneous, continuous curves representing the relationship $x, x' = f(y)$.

In the testing of missiles, engines, nuclear reactions and numerous other studies, the Duplex Function Plotter further helps to accelerate the pace of research. It provides better data by giving scientists a continuous plot of related functions on a single chart, without need for replotting from two separate records. It helps to lift even more of the burden of routine transcribing and data-taking from the shoulders of trained men . . . and frees them for more complete utilization of their skills.

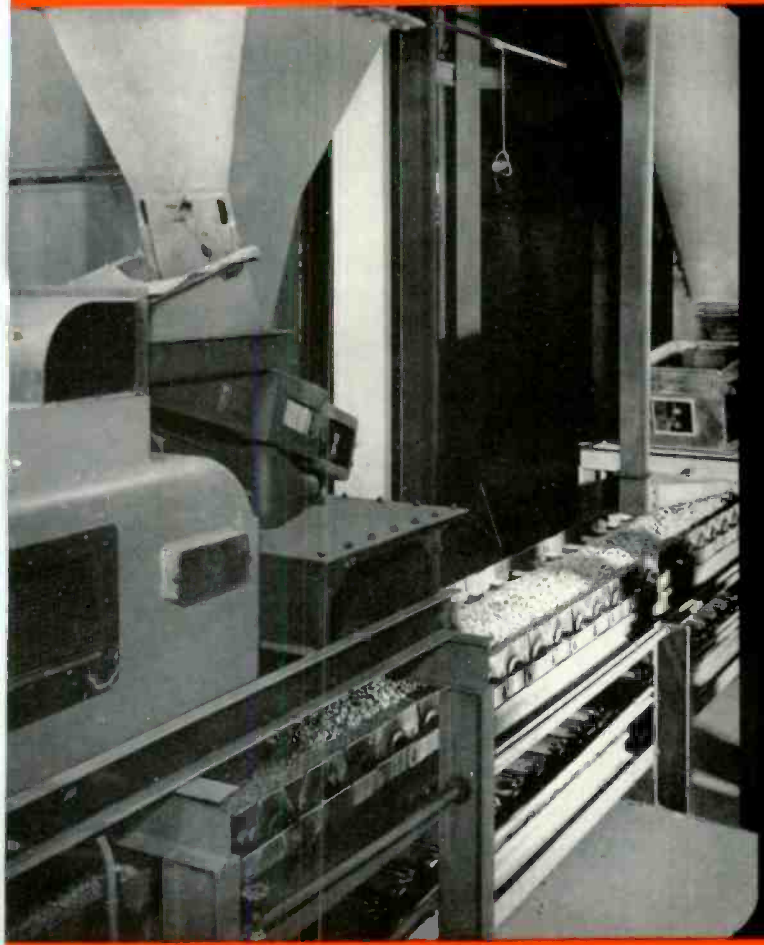
Input to either pen or to the y-axis can be practically any variable that can be converted to a d-c signal. All three inputs can be of different calibrations.

Your local Honeywell sales engineer will welcome the opportunity to discuss your specific applications for this time-saving instrument. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA:** Write for new Data Sheet No. 10.0-17, "*ElectroniK* Duplex Function Plotter."

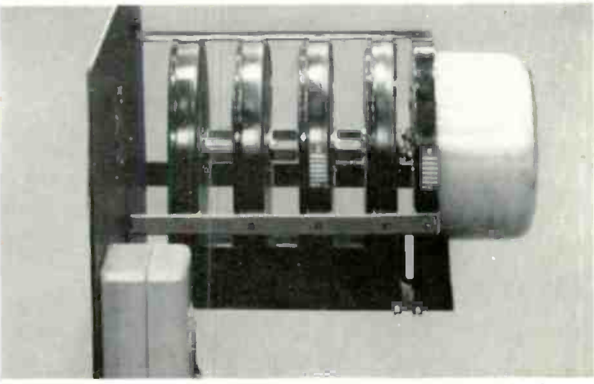
MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls



Guaranteed accurate to within 1%

WAYTROLS PROVIDE continuous proportioning of raw materials.

Whether weighing cornflakes or crushed stone, Ward Leonard rheostats help "Waytrol" feeder measure exact loads



FOUR-DECK, MOTOR-DRIVEN WARD LEONARD RHEOSTAT, shown here on control panel, controls speed of Waytrol delivery belt.

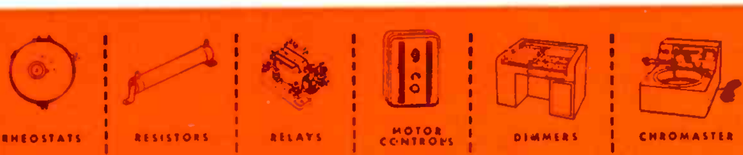
• Here's the machine that practically "spoon-feeds" modern industry. Hundreds of raw materials – from abrasives to zinc ore – are measured out and delivered from one stage of their industrial processing to another on Jeffrey-Traylor weighing, batching and proportioning systems.

Using the weight of the material itself to regulate the amount delivered, these Waytrol systems electronically feed even the most hard-to-handle solids so accurately that variations are held to well within one percent.

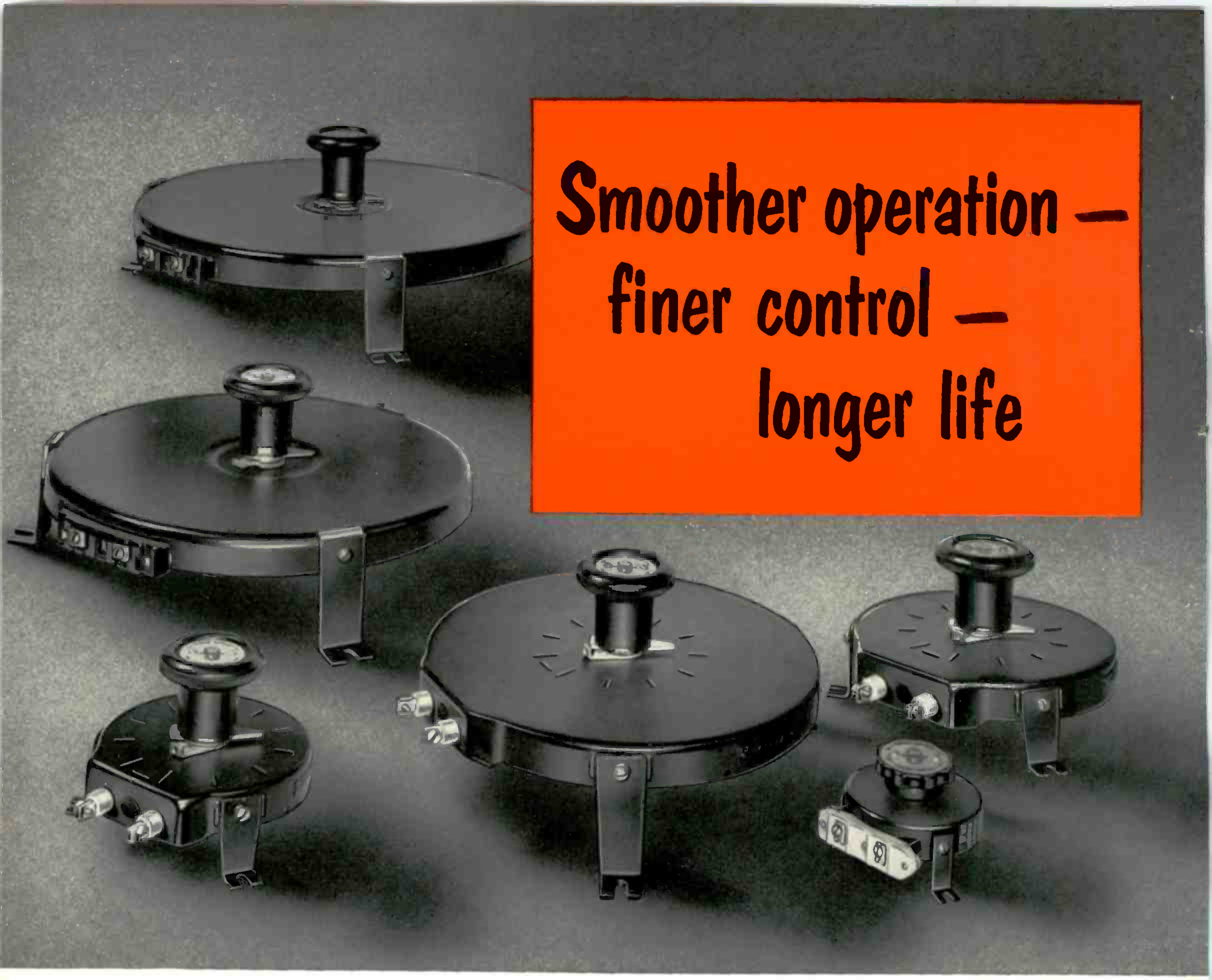
Contributing to this high precision are the Ward Leonard rheostats used to control the output of the vibrating feeder which delivers to the weighbelt. Precise rheostat performance is absolutely essential since "Waytrol" accuracy depends on uniform belt unloading by the feeder.

If accuracy is important in your product, it will pay you to select electrical controls from Ward Leonard's complete line. Write Ward Leonard Electric Co., 300 South St., Mount Vernon, N.Y.

WARD LEONARD
ELECTRIC COMPANY
MOUNT VERNON, NEW YORK



Result-Engineered Controls Since 1892



Smoother operation — finer control — longer life

Here's what you get from the world's most complete rheostat line

• Ward Leonard's new Vitrohm pressed steel rheostats are part of the most complete line of power rheostats ever offered for industrial and commercial applications.

They're designed to provide smoother operation, lower operating torque, longer life and more steps of control. All rheostat materials, from vitreous enamel frit to heat-resistant finish, as well as all manufacturing processes, are carefully controlled by Ward Leonard engineers. After assembly, thorough electrical and mechanical tests guard against any constructional defects.

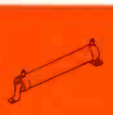
For a complete description of the entire line — with mountings, manual and motor drive accessories, a variety of enclosures and optional features — send for your free copy of Bulletin 60A. Ward Leonard Electric Company, 300 South Street, Mount Vernon, N.Y.

SPECIFICATIONS

Rheostat Size (in inches)	Sigma Watts (2 to 1 current taper)	Steps of Control per Plate			
		Type of Contacts			
		S	M	CC	LB
4	120	43	—	—	—
6	330	41	72	20	—
8	450	41	105	—	—
13	1000	67	161	—	—
15½	1500	—	—	71	99
18	2000	—	—	71	111
15x24	3200	—	—	49	—
FACE PLATE — Standard frame capacity 400 amps. max., 60 control steps					

WARD LEONARD
ELECTRIC COMPANY
MOUNT VERNON, NEW YORK

RHEOSTATS


RESISTORS

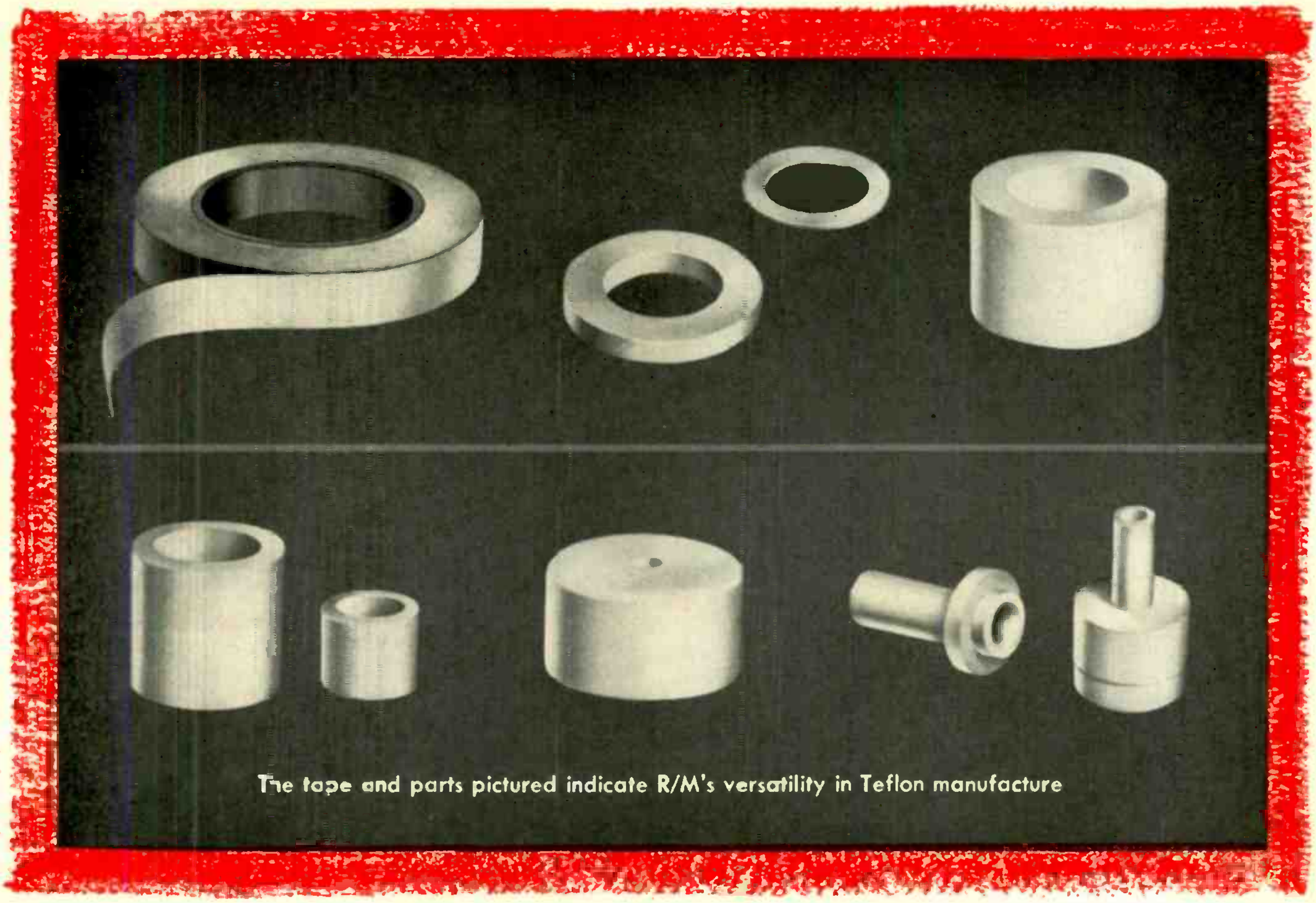
RELAYS

MOTOR CONTROLS

DIMMERS

CHROMASTER

Result-Engineered Controls Since 1892



The tape and parts pictured indicate R/M's versatility in Teflon manufacture

R/M Teflon*

gives you the plus of R/M's unmatched skill, experience, facilities

**Du Pont's trade-mark for its tetrafluoroethylene resin*

Teflon is probably the most important development of the Age of Plastics — its possibilities look endless. Parts made from it are accomplishing things long considered impossible by engineers in the electronics and electrical manufacturing fields.

If you have a problem to be solved, the chances are that R/M, with its unmatched skill, experience and facilities, can solve it. We approach every challenge with the view that nothing is impossible until proved otherwise.

You can rely on R/M for three things: dependable source for Teflon rods, tubes, sheets or tape; fabrication of Teflon parts to your specifications; collaboration in the search for new uses to which this remarkable product can be put.

Teflon Properties: High resistance to acids and gases even at high temperatures • Moisture absorption zero • Unaffected by weather • Excellent heat stability up to 500°F. in continuous operation • As tape, leaves no carbon residue along discharge path • High impact resistance • Nonadhesive • Stretches easily Tensile strength 1500-2500 psi

R/M

RAYBESTOS-MANHATTAN, INC.

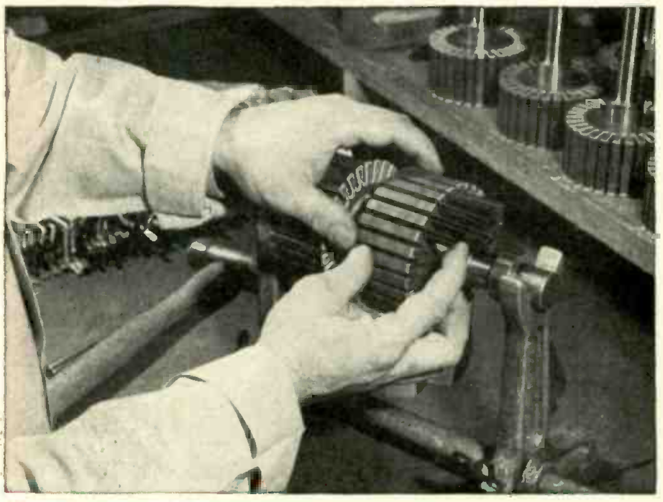
ASBESTOS TEXTILE DIVISION • MANHEIM, PA.

FACTORIES: Manheim, Pa. • No. Charleston, S. C. • Passaic, N. J. • Neenah, Wis. • Crawfordsville, Ind. • Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Manufacturers of Asbestos Textiles • Teflon Products • Packings • Brake Linings • Brake Blocks Clutch Facings • Fan Belts • Radiator Hose • Rubber Covered Equipment • Mechanical Rubber Products • Abrasive and Diamond Wheels Sintered Metal Products • Bowling Balls

Here's how ISOMICA® works for Eclipse-Pioneer*

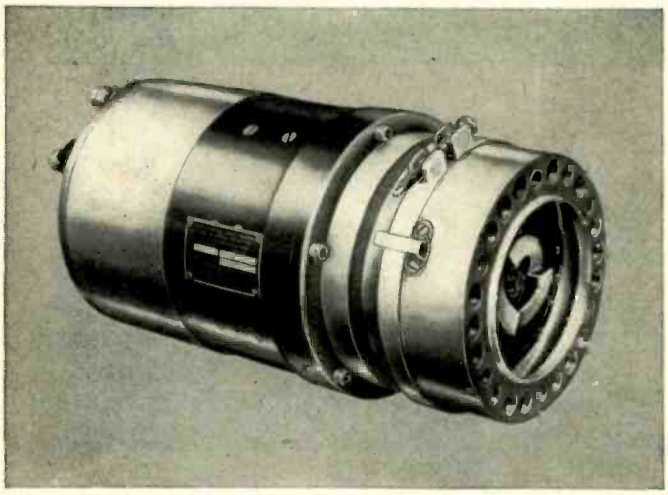
*Division of the Bendix Aviation Corporation



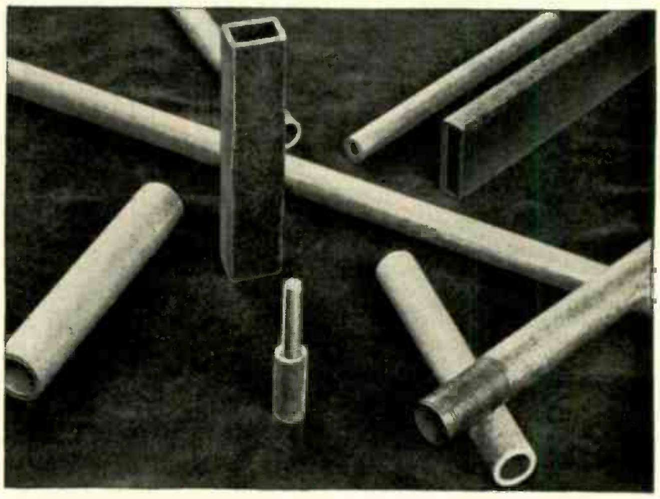
1. As an assembly time-saver, ISOMICA silicone bonded molding plate which has been preformed to armature core slot specifications, is used in one of Eclipse-Pioneer's direct-cranking electrical starters for aircraft gas turbines. ISOMICA silicone bonded molding plate has excellent moldability... excellent retention of shape... high degree of homogeneity.

Eclipse-Pio
Eclipse-Pio

2. Effective insulation from the laminated body of the armature core is assured with the insertion of copper coils into the ISOMICA slot cells—the first step in the Eclipse-Pioneer winding operation. ISOMICA molding plate is free from voids, concentration of mica, and pockets of binder. Structure of ISOMICA molding plate allows smooth, right-angle bends without fracturing.



3. Completed Eclipse-Pioneer direct-cranking electric starter which has been insulated with ISOMICA molding plate. Some of the many other applications of ISOMICA are flexible slot liners; end-bell insulation; high tension terminals and barriers; angles, bushings and washers; coil insulation, heating element insulation, etc.



4. Versatile ISOMICA is made in a variety of forms - miscellaneous ISOMICA tubes (above), tape, molding plate and segment plate, flexible plate and composite materials. These superior materials are made from rolls of thin, continuous mica sheet, impregnated with organic or silicone resins . . . in some cases combined with glass cloth, etc. . . . are uniform in dielectric and mechanical strength.

Whatever electric insulation material you need—Class A to Class H—standard or special—MICO makes it best. We manufacture it, cut it to size, or fabricate it to your specifications. Send us your blueprints or problems today.

MICO ELECTRICAL INSULATION ®

MICA *Insulator* COMPANY

Schenectady 1, New York

Offices in Principal Cities

In Canada—Micanite Canada, Ltd., Granby, Quebec

LAMICOID ® (Laminated Plastic) • **MICANITE** ® (Built-up Mica) • **EMPIRE**® (Varnished Fabrics and Paper) • **FABRICATED MICA** • **ISOMICA**®

The New Servoscope® puts another engineer on your staff

... but not on your payroll

The New Servoscope Saves Man-Hours

Are you engineering any type of feedback control system—regulators, governors, process controls, positioning or speed servos? With a Servoscope an extra engineer will be working for you on design synthesis, analysis or production test.

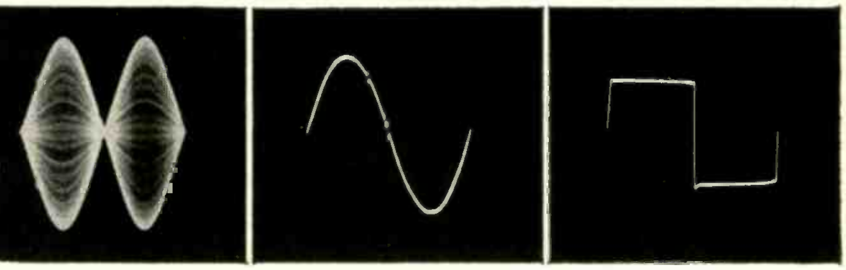
Discovers Mistakes Before You Make Them

Breadboard your intended servo system or other circuit designs—then, by either the frequency response or the transient response method, magnitude and phase curves can be obtained directly within minutes.

The Servoscope is available in two standard models - 1100A (0.1 to 20 cps.), 1100B (.15 to 30 cps.). Custom modifications for higher frequencies and units with built-in oscilloscopes quoted on request.

For detailed information on how this versatile test instrument can save manpower, materials and money, write Dept. E-7

Output wave forms of Servoscope displayed against internal linear sweep generator, frequency ½ cps.



SERVO CORPORATION OF AMERICA

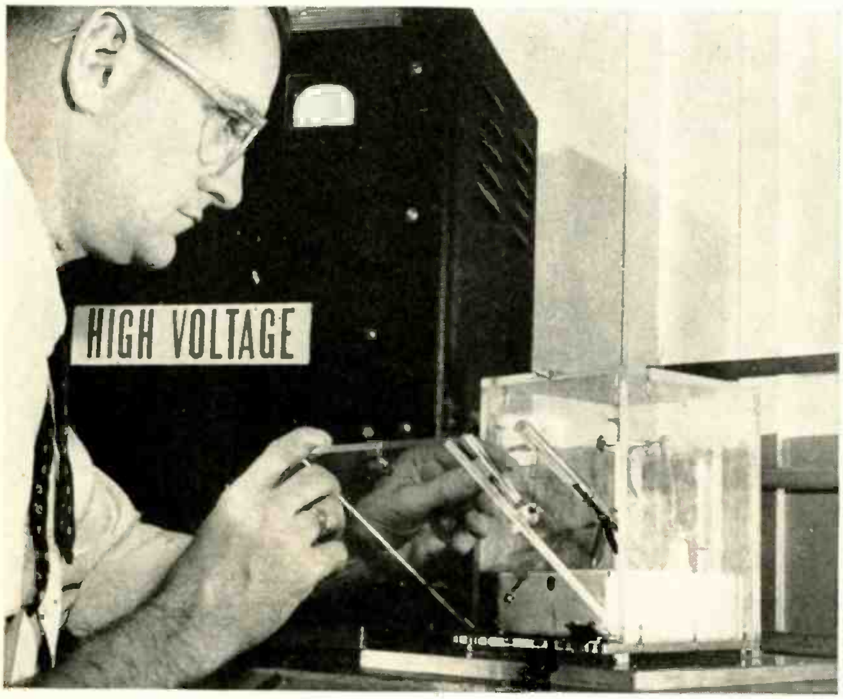
New Hyde Park, New York

SC 115

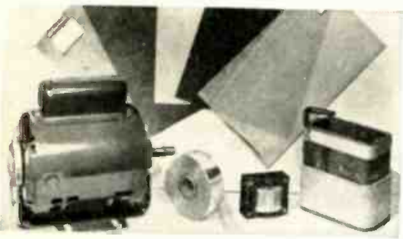
New Du Pont MYLAR offers this unique balance of properties:

REG. U. S. PAT. OFF.

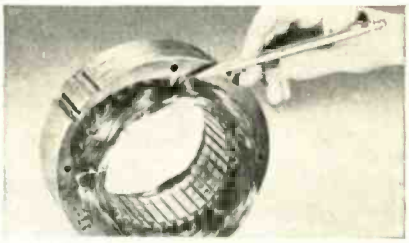
- **High dielectric strength**
- **Exceptional thinness**
- **High tensile strength**
- **Thermal stability**
- **Chemical inertness**



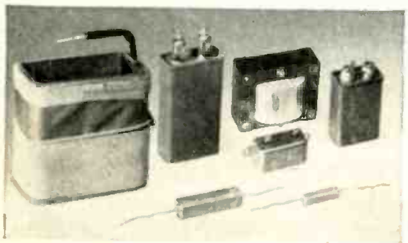
Capacitor testing in this jig confirms the high dielectric strength of "Mylar" . . . over 4000 volts per mil.



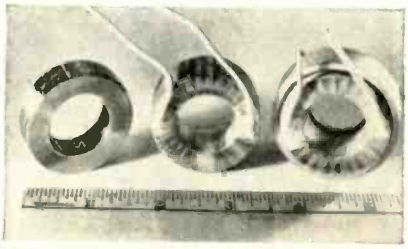
Exceptional tensile strength of "Mylar," 23,500 lbs. per sq. in., permits manufacture of rugged electrical components.



"Mylar" film that is used to insulate this stator is about half as thick as the material it replaces.



Size reduction of capacitors, transformers and other electrical equipment is made possible by the use of "Mylar."



High dielectric strength, combined with toughness, makes "Mylar" adaptable to a variety of coil insulating uses.

New possibilities in the design of electrical equipment are opened by a new product of Du Pont research—"Mylar" polyester film. The unusual balance of electrical, mechanical and chemical properties offered by this film makes it suitable for a wide variety of insulating applications.

"Mylar" exhibits excellent dielectric strength, high volume and surface resistivity. Its tensile strength, one third that of machine steel, permits its manufacture in gauges ranging from ¼ of a mil (0.00025 inch) to 7½ mils (0.0075 inch). "Mylar" retains its remarkable properties over a wide temperature range, remaining flexible and stable from -60° to 150°C.

"Mylar" is moisture- and solvent-insensitive . . . unaffected by most organic and inorganic vapors. Its use under a variety of climatic conditions is possible because "Mylar" is completely fungus and mildew-proof.

A new booklet is now available to show where this versatile film's properties can be used to advantage. If you would like a copy to help you evaluate the possibilities of "Mylar" for improving your products, write to: E. I. du Pont de Nemours & Co. (Inc.), Film Dept., Room 2E, Wilmington 98, Del.

DU PONT
MYLAR®

Polyester Film

DU PONT

REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
. . . *THROUGH CHEMISTRY*

PHILCO "STEPS UP" TRANSISTOR PRODUCTION

to meet the demands of the industry

Superior Performance makes Philco Transistors the recognized standard. With Philco Alloy Junction Transistors you gain the advantages of small size, low power consumption and simplified circuitry to improve your product.

RELIABILITY . . . six years of Philco research and development in semi-conductors have established the quality, uniformity and production standards (from basic materials to tested transistors) required for large scale production.

AVAILABILITY...recognizing the potential transistor requirements of the electronic industry, Philco planning has resulted in production facilities which assure an unfailing supply of high quality transistors—now!

Phone, write or wire Dept. E today for descriptive literature and specifications on Philco transistors.

PHILCO TRANSISTORS FEATURE . . .

- *Maximum reliability*
- *Hermetically-sealed resistance-welded case . . . leads fused in glass*
- *Uniform characteristics*
- *Minimum size*
- *Ruggedized construction*

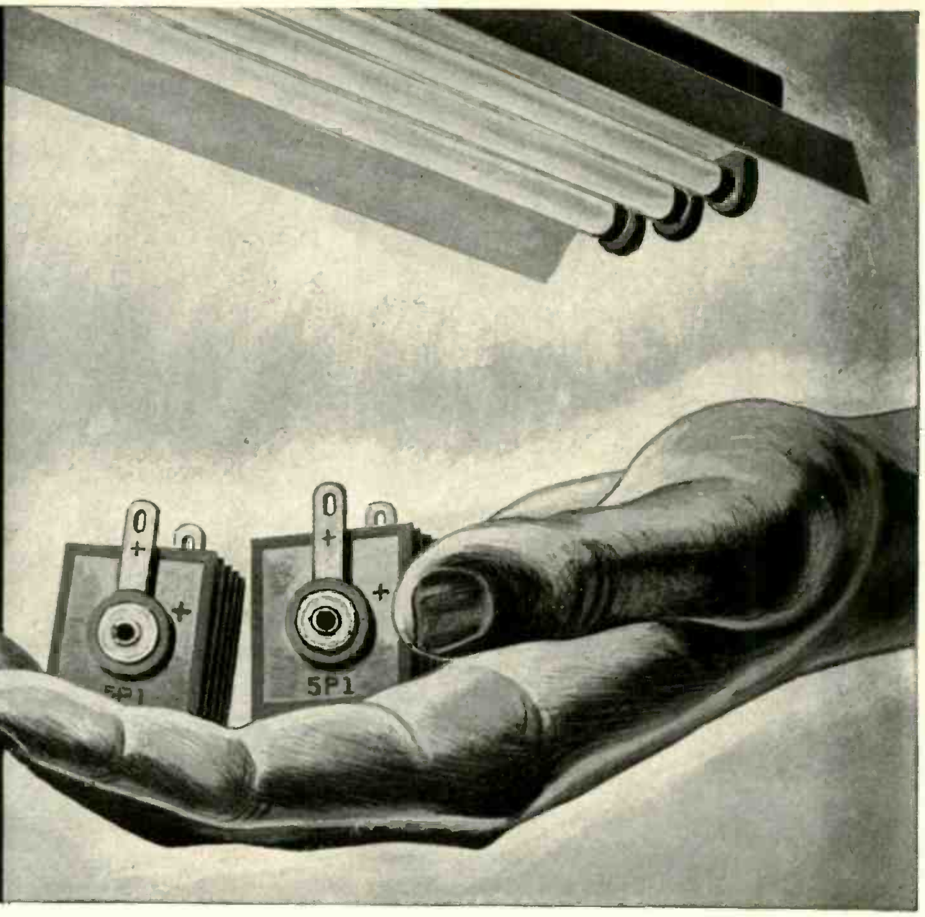
PHILCO
Famous for
QUALITY
the World Over

PHILCO CORPORATION

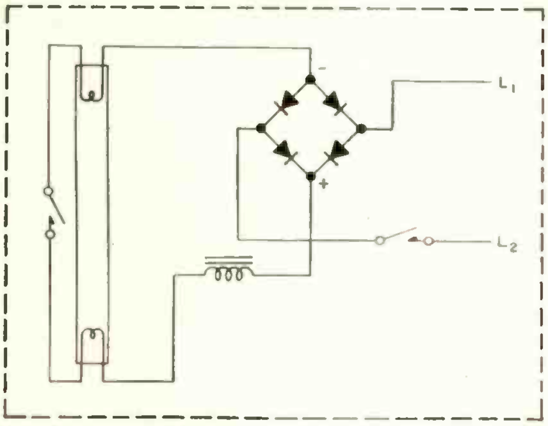
GOVERNMENT & INDUSTRIAL DIVISION • PHILADELPHIA 44, PA.

Remarkable life results reported in unique application

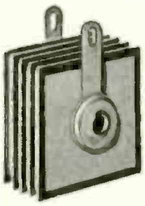
Seletron



SELENIUM RECTIFIERS



Circuit for eliminating fluorescent flicker in 25 cycle and universal operation, as used in "Noflik" lights.



PLACED IN BRILLIANT LIGHT BY SPECIAL FLUORESCENT FIXTURES

WOULDN'T YOU be *"light*hearted" if you received a comment like this? *We* were when Canadian Fluorescent Co.'s president wrote: "During the six years that thousands of "Noflik" lights equipped with your rectifiers have been in use — in many cases under continuous operation — we have found Radio Receptor units to be remarkably long-lived and entirely satisfactory."

Canadian Fluorescent, which has licked the flicker in 25 cycle fluorescent lighting with its "Noflik" fixtures, uses four half wave radio type RRCO. selenium rectifiers and a specially designed ballast.

Radio Receptor rectifiers as well as RRCO. germanium transistors and diodes are *"Really Reliable."* Find out for yourself. If you have a problem where these fine components could be used, make sure to ask us for engineering data. We'll gladly supply it without obligation . . . And request our comprehensive new 24 page rectifier bulletin No. 177-E.

Seletron & Germanium Division

RADIO RECEPTOR COMPANY, INC.

In Radio and Electronics Since 1922

SALES OFFICES: 251 WEST 19TH STREET, NEW YORK 11, N. Y.
TELEPHONE: WATKINS 4-3633 • FACTORIES IN BROOKLYN, N. Y.

Really Reliable!

we're prepared NOW to supply you in quantity with

Midland

FREQUENCY CONTROL CRYSTALS for Color Television

◆ **CRYSTAL CONTROLLED REACTANCE TUBE OSCILLATOR FOR COLOR SYNCHRONIZATION**

To obtain the maximum advantage of Crystal Control in a reactance tube oscillator combination, the Midland Engineering staff has developed a crystal controlled Reactance Tube Oscillator Circuit for color synchronization.

The unit is Custom engineered to provide an inexpensive complete circuit and to take full advantage of the crystal characteristics to give optimum performance.

This is available to the television industry in sub-assembly form.

Midland was far in advance in the development and perfecting of frequency control crystals and circuits for color TV. Experimental production started in 1952.

Midland has met the exacting requirements of color television with a crystal of complete reliability. An early and thoroughly sound solution to each new challenge is in keeping with the Midland background of having served the communications field with millions of crystals that perform dependably under the most severe conditions.

Midland's unequalled experience, critical quality control at every stage of production, and expanded plant capacity assure you dependable, fast crystal supply—in any quantity—to meet your exact specifications.

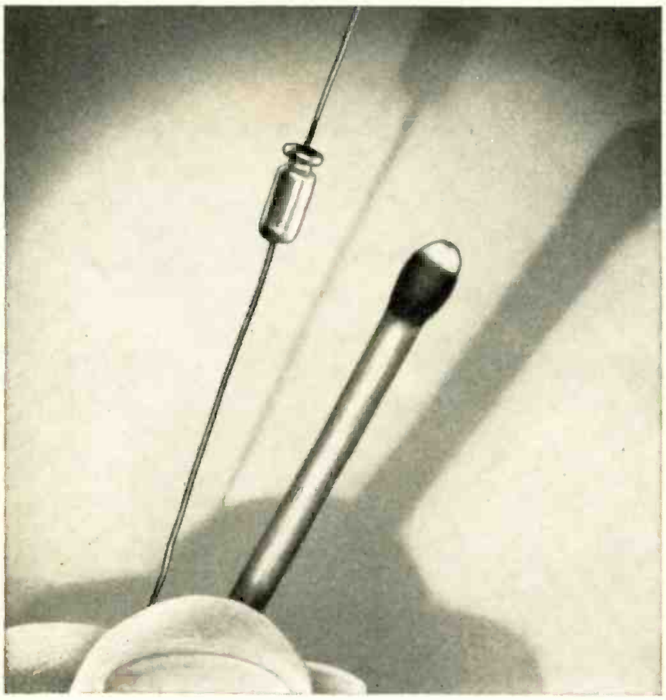
Whatever your Crystal need, conventional or specialized,
When it has to be exactly right, contact

Midland MANUFACTURING COMPANY, INC.
3155 Fiberglas Road • Kansas City, Kansas

WORLD'S LARGEST PRODUCER OF QUARTZ CRYSTALS

DESIGNER'S

Micro-miniature Tantalytic capacitors give new design flexibility

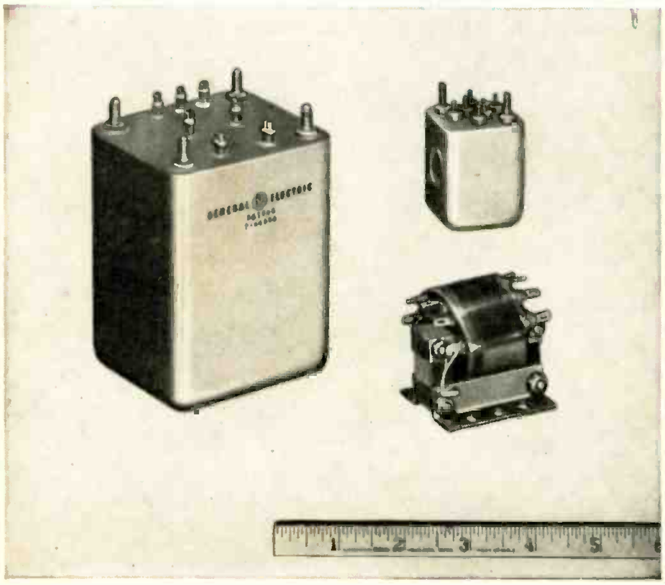


Smallest electrolytic capacitors commercially available

Micro-miniature Tantalytic capacitors can now be supplied in ratings up to 20 volts, or, up to 8 microfarads in the $\frac{5}{16}$" long case—higher capacitance in a ½" case size . . . with −0% to +100% capacitance tolerance. They give you new design flexibility in low-voltage, d-c circuits—particularly transistorized subminiature assemblies where space is at a premium.

Designed especially for nonresonant, noncritical applications such as coupling, by-pass and filtering, G-E micro-miniature Tantalytic capacitors outperform aluminum electrolytics in electrical stability, operating and shelf life because of the inert characteristics of tantalum metal. They operate over a −20C to +50C range and may be stored at −65C. With some capacitance derating, Tantalytic capacitors perform well below −20C—with some life limitations they will also perform satisfactorily above +50C.

You may obtain samples 2 to 3 weeks after your order is received at the factory. Production lots are supplied 6 to 8 weeks after the order is received. For more information see your G-E Apparatus Sales representative, or write for Bulletin GEA-6065.



G.E. builds dependability into electronic transformers—3 ways

From laboratory samples to the last production model, dependability is built into G-E electronic transformers. Here's how:

1. INTEGRATED FACILITIES: G-E labs, testing facilities, and materials sources are co-ordinated to help get you the transformers you want—when you want them.
2. MECHANIZATION: The G-E plant is mechanized and staffed to handle large-quantity production, while maintaining laboratory sample quality.
3. EXPERIENCE: G-E personnel have worked hand-in-hand with electronics manufacturers for years and consequently keep *your* problems in mind as they produce transformers for your particular, specialized applications. See your G-E Apparatus Sales representative for more information.

GENERAL ELECTRIC

DIGEST

TIMELY HIGHLIGHTS ON G-E COMPONENTS

New electronic relays have high sensitivity

This new electronic resistance-sensitive relay is able to amplify minute currents carried by very delicate contacts. Even a wet thread will provide enough signal for it to operate.

Sensitivity level is set by adjusting dial, which can be locked in place. The relay may be remotely controlled from as far away as 500 feet. Each can be set for either "normal" (relay "drops-out") or "reverse" (relay "picks-up") operation of the magnetic relay included in the device.

Built for long life, its enclosure is weather-resistant and dust-tight. Terminals are easily accessible; all components of this G-E relay are open for ease in servicing. For further information send for Bulletin GEA-5893.

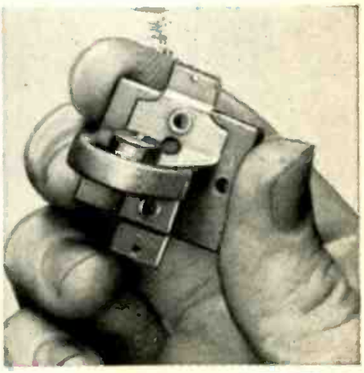
Fast, accurate circuit analysis

This self-contained, highly stable G-E self-balancing potentiometer rapidly converts small d-c voltages to measureable currents—*without* loading the measured circuit—for analysis of electronic circuits. It is consistently accurate because simple controls, and automatic, rapid circuit balance minimize operator errors. Easily changed resistor permits selection of input ranges from 100 microvolts to one volt d-c full scale with 5-milliampere d-c output. See Bulletin GEC-367.

Tiny signals amplified

Combining amplifying and rectifying elements in a unit, G-E amplistats (self-saturating magnetic amplifiers) "sense" small signal changes, amplify them greatly, and impart the amplified signal to a system to obtain the desired control. They give you the practical advantages of virtually instantaneous response, low power consumption, long life, and electrical signal isolation. Obtain assistance in applying G-E amplistats at your G-E Apparatus Sales Office. See Bulletin GEA-5950.

Small rectifier has high output



G-E germanium rectifiers offer the highest output in the smallest of rectifiers. For example, the dime-sized, sealed, air-cooled type is available in ratings up to 50 volts, 0.4 amperes d-c. Germanium rectifiers have these advantages: *high efficiency*—operate 98% to 99% efficient; *compactness*—small size and weight per watt output means you can build more compact assemblies; and *long life*—two-year life tests show no detectable aging. Write for Bulletin GEA-5773.

EQUIPMENT FOR ELECTRONIC MANUFACTURERS

Components

- Meters, instruments
- Dynamotors
- Capacitors
- Transformers
- Pulse-forming networks
- Delay lines
- Reactors
- Motor-generator sets
- Inductrols
- Resistors
- Voltage stabilizers
- Fractional-hp motors
- Rectifiers
- Timers
- Indicating lights
- Control switches
- Generators
- Selsyns
- Relays
- Amplidynes
- Amplistats
- Terminal boards
- Push buttons
- Photovoltaic cells
- Glass bushings

Development and Production Equipment

- Soldering irons
- Resistance-welding control
- Current-limited high-potential tester
- Insulation testers
- Vacuum-tube voltmeter
- Photoelectric recorders
- Demagnetizers

General Electric Company, Apparatus Sales Division
Section D667-28, Schenectady 5, New York

Please send me the following bulletins:
✓ for reference only X for planning on immediate project

☐ GEA-5773 Germanium Rectifiers
☐ GEA-5893 Electronic Resistance Sensitive Relay
☐ GEA-5950 Amplistats
☐ GEA-6065 Micro-miniature Tantalytic Capacitors
☐ GEC-367 Self-balancing Potentiometer

Name ....

Company ....

City .... State ....

KEPCO

VOLTAGE REGULATED POWER SUPPLIES

VOLTS	CURRENT	REGULATION	RIPPLE	6.3 V.† AC. CT.	MODEL
0-1500	0-200 Ma.	0.5%	20 Mv.		1520
0-1200	0-20 Ma.	0.1%	10 Mv.	10 Amp.	1220
0-1000	0-500 Ma.	0.5%	20 Mv.		1350
200-1000	0-500 Ma.	0.5%	20 Mv.		1250
0-1000	0-50 Ma.	0.1%	10 Mv.	10 Amp.	1020
0-600	0-3 Amp.	0.5%	10 Mv.		780
0-600	0-2.25 Amp.	0.5%	10 Mv.		770
0-600	0-1.5 Amp.	0.5%	10 Mv.		760
0-600	0-750 Ma.	0.5%	10 Mv.		750
0-600 0-150 Bias	0-300 Ma. 0-5 Ma.	0.5% •	10 Mv. 5 Mv.	10 Amp.	615
0-600	0-300 Ma.	0.5%	10 Mv.	10 Amp.	500R
#1 0-600 #2 0-600	0-200 Ma. 0-200 Ma.	0.5% 0.5%	5 Mv. 5 Mv.	10 Amp. 10 Amp.	800
0-600 0-150 Bias	0-200 Ma. 0-5 Ma.	0.5% •	5 Mv. 5 Mv.	10 Amp.	815
#1 200-500 #2 200-500	0-200 Ma. 0-200 Ma.	0.5% 0.5%	5 Mv. 5 Mv.	6 Amp. 6 Amp.	510
200-500	0-200 Ma.	0.5%	5 Mv.	6 Amp.	245
0-400 0-400 0-150 Bias	0-150 Ma. 0-150 Ma. 0-5 Ma.	0.5% 0.5% •	5 Mv. 5 Mv. 5 Mv.	10 Amp. 10 Amp.	2400
0-400 0-150	0-150 Ma. 0-5 Ma.	0.5% •	5 Mv. 5 Mv.	10 Amp.	400
0-400	0-150 Ma.	0.5%	5 Mv.	10 Amp.	141
100-400	0-150 Ma.	0.01%	1 Mv.	10 Amp.	2000
0-350	0-3 Amp.	0.5%	10 Mv.		730
0-350	0-2.25 Amp.	0.5%	10 Mv.		720
0-350	0-1.5 Amp.	0.5%	10 Mv.		710
0-350	0-750 Ma.	0.5%	10 Mv.		700
100-325 0-150 Bias	0-150 Ma. 0-5 Ma.	0.5% •	5 Mv. 5 Mv.	10 Amp.	131
0-300 0-150 Bias	0-150 Ma. 0-5 Ma.	0.5% •	5 Mv. 5 Mv.	5 Amp.	315
0-150	0-50 Ma.	0.5%	5 Mv.		150
3-30	0-30 Amp.	0.5%	0.1%		3030
1-13	0-10 Amp.	0.5%	10 Mv.		3200

MODEL 750

MODEL	VOLTS	CURRENT	REGULATION	RIPPLE
750	0-600	0-750 Ma.	0.5%	10 Mv.
760	0-600	0-1.5 Amp.	0.5%	10 Mv.
770	0-600	0-2.25 Amp.	0.5%	10 Mv.
780	0-600	0-3 Amp.	0.5%	10 Mv.

DC POWER SUPPLY SPECIFICATIONS

KEPCO Voltage Regulated Power Supplies are conservatively rated. The regulation specified for each unit is available under all line and load conditions within the range of the instrument.

REGULATION: As shown in table for both line fluctuations from 105-125 volts and load variations from minimum to maximum current.

***REGULATION FOR BIAS SUPPLIES:** 10 millivolts for line 105-125 volts. ½% for load at 150 volts.

†All AC Voltages are unregulated.

WORKMANSHIP

Workmanship is of a quality with the highest existing production standards and best instrument electronic practices consistent with the intended use of the item as a continuous duty voltage regulated power supply. Oil filled paper condensers and resistor-board construction are included in the design.

FOR NEW POWER SUPPLY CATALOG — WRITE DEPT. No. 789

MANUFACTURERS OF ELECTRONIC EQUIPMENT • RESEARCH • DEVELOPMENT

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LABORATORIES
131-38 SANFORD AVENUE • FLUSHING 55, N. Y. • INDEPENDENCE 1-7000

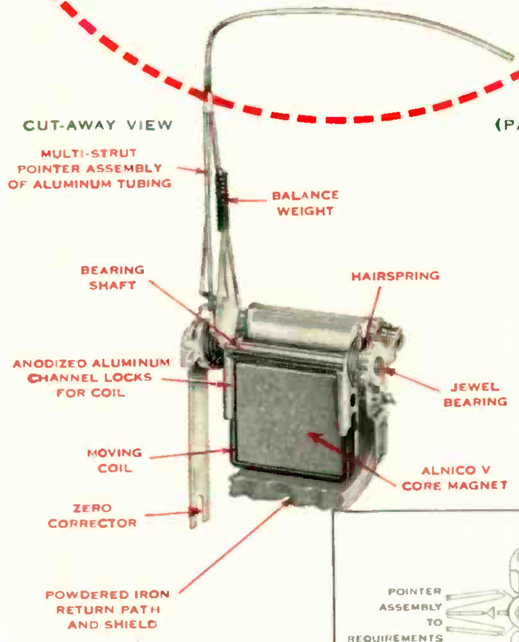
marion

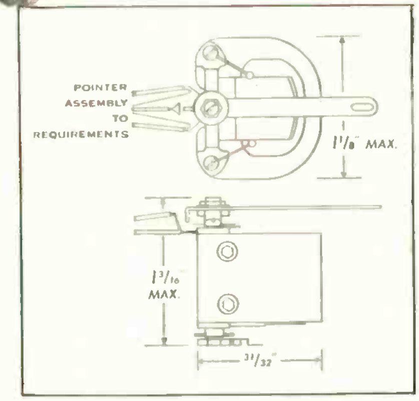
advancement in instrument design

POWERFUL MOVING COIL MECHANISM HAS GYRO-LIKE STABILITY

TWO VIEWS SHOWING MECHANISM ACTUAL SIZE

(PATENTS PENDING)


CUT-AWAY VIEW
MULTI-STRUT POINTER ASSEMBLY OF ALUMINUM TUBING
BALANCE WEIGHT
BEARING SHAFT
HAIRSPRING
ANODIZED ALUMINUM CHANNEL LOCKS FOR COIL
JEWEL BEARING
MOVING COIL
ALNICO V CORE MAGNET
ZERO CORRECTOR
POWDERED IRON RETURN PATH AND SHIELD


POINTER ASSEMBLY TO REQUIREMENTS
1⅛" MAX.
1 3/16 MAX.
31/32"

The Marion Type MEP-1 meter mechanism was designed to develop highest possible torque for a given volume of magnetic material. Its high torque, heavy eddy current damping and low relative inertia provide unusual performance characteristics simulating the stability of a gyro, in like environment. Already it is setting new and higher standards for reliability in moving coil indicating mechanism design for aircraft application, where the influence of vibration and rapid attitude changes on pointer indication are significant factors.

The gyro-like stability of the MEP-1 mechanism results from its unique mechanical design. An end-pivoted coil assembly, with a one piece bearing shaft and precise mechanical assembly operates in a self-shielded magnet structure which produces approximately 6000 Gauss in a single air gap. When the end-pivoted moving coil, of long turning radius, operates in a magnetic field of such strength, substantial gains in torque and eddy current damping are realized. This great torque, combined with relatively light weight, permits unit bearing loadings substantially lower (i. e. larger pivot and jewel radii) than heretofore normal.

MECHANISMS BY MARION

Although developed expressly for application in aircraft navigational instruments, many of the MEP-1 characteristics make it desirable for use as the sensitive element in control devices where it is required to initiate a control function. It is one of a number of Mechanisms by Marion that extend the field o moving coil mechanism application where previously size, weight or performance characteristics prevented their use

Marion Electrical Instrument Company,
401 Canal Street, Manchester, N. H.

MILLIAMPERES

marion meters

Reg. U. S. Pat. Off.

MANUFACTURERS OF RUGGEDIZED AND "REGULAR" METERS AND RELATED PRODUCTS

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MICROWAVE Associates INCORPORATED

33 Cummington Street, Boston 15, Mass.
Telephone COpley 7-7577

ATR, TR, MAGNETRON TUBES AND SILICON DIODES WAVEGUIDE COMPONENTS AND TEST EQUIPMENT

This is a partial listing.
Send for complete catalog literature.

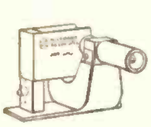
SILICON DIODES

IN 23B
MICROWAV

	CENTER FREQUENCY (mc)	MAX CONVER LOSS (db)	MAX NOISE RATIO (times)	VSWR (max)	IF IMPEDANCE (OHMS)
•IN21B	3060	6.5	2.0	–	200–800
•IN21C	3060	5.5	1.5	–	200–800
•IN150	6750	6.0	2.0	1.5	250–500
•IN160	6750	6.5	2.7	–	200–800
•IN23B	9375	6.5	2.7	–	200–800
•IN23C	9375	6.0	2.0	1.5	325–475
•IN149	9375	5.5	1.5	1.5	325–475
IN78	16000	7.5	2.5	–	325–625
IN26	23984	8.5	2.5	–	300–600
IN53	>30000	8.5	2.5	–	400–800
IN32	3295	Fig. Merit >85		Video Impedance 4K–22K	

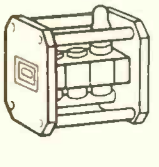
• Also available with reversed polarity

MAGNETRONS



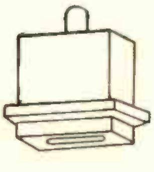
TUBE TYPE	FREQUENCY Mc	NOMINAL PEAK OUTPUT KW	PEAK VOLTAGE ANODE KV	VOLTAGE RATE OF RISE KV/µs	AV. ANODE CURRENT MA	PEAK ANODE CURRENT A	PULSE DURATION µs	DUTY CYCLE	PULLING FACTOR (max) Mc	INITIAL HEATER VOLTAGE V	INITIAL HEATER CURRENT A
5789	34512-35208 34512-35208 34512-35208	40 30 20	10.0-13.0 10.0-13.0 10.0-13.0	110-120 110-120 110-120	5.0 6.5 6.0	20.0 15.0 10.0	0.25 0.5 1.0	.00025 .0004 .0006	40 40 40	6.0 6.0 6.0	2.0-2.4 2.0-2.4 2.0-2.4
2J42	9345-9405 9345-9405 9345-9405	8 8 8	5.3-5.7 5.3-5.7 5.3-5.7	60 60 60	9.0 4.0 2.9	4.5 4.5 4.5	1.0 2.2 0.8	.002 .0009 .00065	15 15 15	6.3 6.3 6.3	0.43-0.60 0.43-0.60 0.43-0.60
6027 (2J42A)	9345-9405 9345-9405	20 10	6.4-7.4 6.0-7.0	60 60	7.5 7.0	7.5 3.5	1.0 1.0	.001 .002	15 15	6.3 6.3	0.43-0.53 0.43-0.53
4J52	9345-9405 9345-9405	80 80	14.0-16.0 14.0-16.0	100 100	15.0 15.0	15.0 15.0	1.0 5.0	.001 .001	15 15	12.6 12.6	1.8-2.4 1.8-2.4
6444 (ESM-48)	9800-10000	0.001 CW	0.45-0.50	—	15.0	.015	CW	1.0	15	6.0	0.4-0.5

TR TUBES



TUBE TYPE	FREQUENCY RANGE Mc	LOW LEVEL UNFIRED RATINGS: VSWR max	INSERTION LOSS db	IGNITOR INTER-ACTION db	IGNITOR DROP 100µA — V	HIGH LEVEL FIRED RATINGS: PEAK POWER KW	FLAT LEAKAGE MW	SPIKE LEAKAGE ergs	RECOVERY TIME µs @ —3db	ARC LOSS db	VSWR max
1B63A	8490-9578	1.9	.3-.7	0-.2	200-375	4-200	10-40	.05-.2	1-10	.8-.1	—
6334	8490-9578	1.4	—	0-.2	200-375	4-200	0-20	0-.1	1-10	.8-.2	1.2
5863	8490-9578	1.9	.3-.7	0-.3	250-400	4-1000	5-30	.05-.15	1-8	.8-.1	—
6164	8490-9560	2.0	.3-.7	0-.3	250-400	4-1000	5-30	.05-.15	1-8	.8-.1	—
1B58	2659-2969	1.65	.3-.5	0-.3.	250-400	10-750	10-40	.05-.3	3-15	.7-.1	1.15
5927	3070-3530	1.9	.3-.7	0-.3	275-425	10-750	10-50	.05-.3	3-15	.7-.1	1.15

ATR TUBES



TUBE TYPE	FREQUENCY RANGE Mc (VSWR 10 1)	LOW LEVEL UNFIRED RATINGS: MIN. ISOLATION db	LOADED Q max	TUNING SUSCEP-TANCE	EQUIVALENT CONDUCT-ANCE max	HIGH LEVEL FIRED RATINGS: PEAK POWER KW	RECOVERY TIME µs	ARC LOSS db	VSWR max	MECHANICAL MOUNT
1B35A	9000-9600	12	6.5	±.06	0.1	4-250	2-20	.8-.1	1.1	Choke Socket
6163 †	8800-9300	12	6.5	±.06	0.06	4-250	2-20	.8-.1	1.1	Choke Socket
1B37A	8500-9000	12	6.5	±.06	0.1	4-250	2-20	.8-.1	1.1	Choke Socket
5864	9000-9600	12	8.0	±.06	0.1	4-500	2-20	.8-.1	1.1	Choke Socket
6276	9000-9600	12	6.5	±.06	0.1	4-250	2-20	.8-.1	1.1	Woven Braid Gasket
6284	8500-9000	12	6.5	±.06	0.1	4-250	2-20	.8-.1	1.1	Woven Braid Gasket
6393	9000-9600	12	6.5	±.06	0.1	4-250	2-20	.8-.1	1.1	Molded Rubber-Metal Gasket
6369	8500-9000	12	6.5	±.06	0.1	4-250	2-20	.8-.1	1.1	Molded Rubber-Metal Gasket
6396 †	8700-9700	10	6.5	±.06	0.1	4-250	2-20	.8-.1	1.1	Molded Rubber-Metal Gasket
1B56	2750-2950	10	5.5	±.05	0.05	20-1000	2-25	.8-.1	1.15	Woven Braid Gasket
6024	2700-2900	10	5.5	±.05	0.05	20-750	2-20	.8-.1	1.15	Woven Braid Gasket
5921	3100-3300	10	5.5	±.05	0.05	20-1000	2-25	.8-.1	1.15	Woven Braid Gasket
5922	3300-3500	10	5.5	±.05	0.05	20-1000	2-25	.8-.1	1.15	Woven Braid Gasket

† 2 tubes series-mounted back-to-back.

SALES REPRESENTATIVES

J. E. HACHTEN CO. 8413 Las Tunas Drive
San Gabriel, California CUmberland 3-3860

E.R.A., INCORPORATED 10 South Middle Neck Rd.
Great Neck, New York GReat Neck 4-9320

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Rochester, New York HIllside 2712

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Chicago, Illinois ROgers Park 4-6121

KEN RANDALL CO. 121 N. Broad Street
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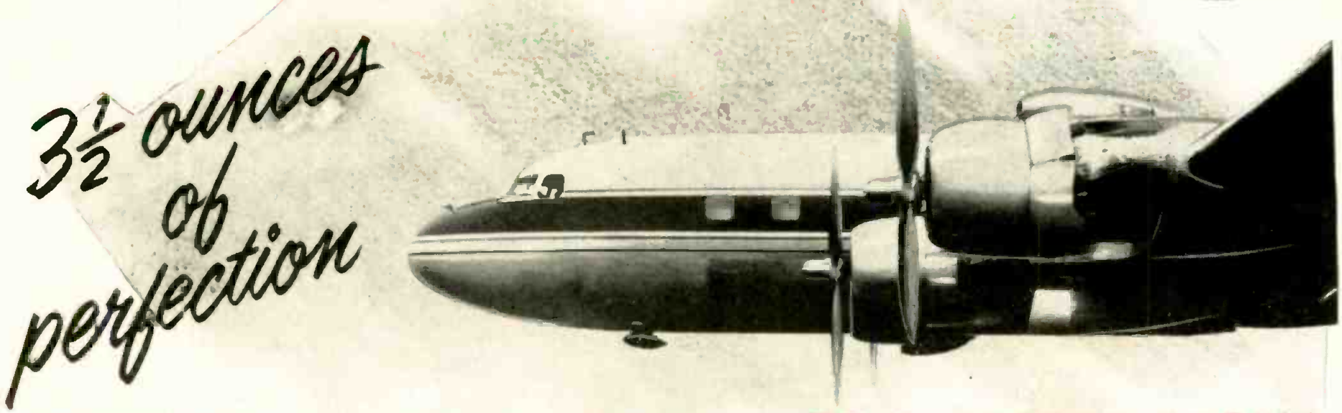
KEN RANDALL CO. 1303 Midvale Avenue
Baltimore, Maryland RIdgeway 7-5260

ENGINEERING SERVICES CO. 6635 Delmar Blvd.
St. Louis, Missouri VOlunteer 3-3661

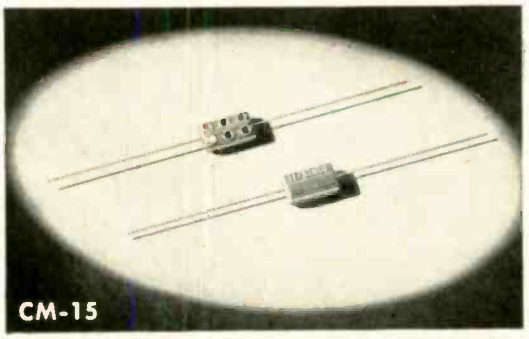
SOUTHWEST ELECTRONIC IND. 4515 Prentice St.
Dallas, Texas FOrest 8-8306

trifles make PERFECTION... but PERFECTION is no trifle

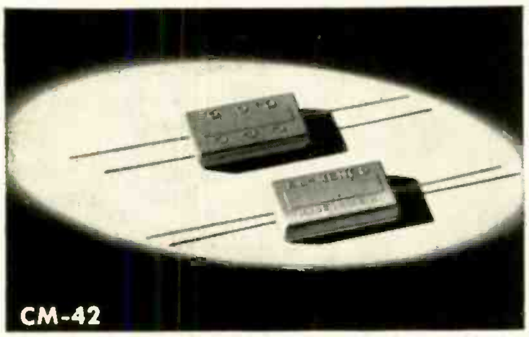
#1 IN A SERIES OF TREMENDOUS TRIFLES



is VITAL to 61 TONS of MAGNIFICENT PERFORMANCE


CM-15

Smallest Molded Mica Capacitors 9/32" x 1/2" x 3/16"


CM-42

Made to Meet All MIL-C-5 Requirements. Largest Molded Mica Capacitors of Wire Terminal Type. 13/16" x 1-1/2" x 5/16"

Jobbers and Distributors are requested to write for information to Arco Electronics, Inc., 103 Lafayette St., New York, N. Y. — large stocks on hand — spot shipments for immediate delivery. Sole Agent for Jobbers and Distributors in U. S. and Canada.

When the mighty giants of the air lift their massive wings to fly, a thousand and more "tremendous trifles" instantly go to work in harmonious unison to give life and power. It is the perfection of these "trifles" that makes possible the magnificent performance of today's luxurious air liners.

The EL MENCO Capacitor—CM-15—is one of these "tremendous trifles" that plays such a vital part in the efficient operation of aircraft communication.

EL MENCO IS THE ONE OUT OF MANY CHOSEN FIRST

Superiority of manufacture and dependability of performance make EL MENCO first choice on the specification sheet . . . because EL MENCO Capacitors are factory-tested at *double their working voltage* — they are *guaranteed stable* under the most adverse conditions. Whether you use our *high* capacity CM-42 (10-25,000 mmf) or our midget *low* capacity CM-15 (2-525 mmf) you have guaranteed assurance of job-tested, job-rated capacitors — tremendous trifles of perfection so vital to the magnificent performance of YOUR product.

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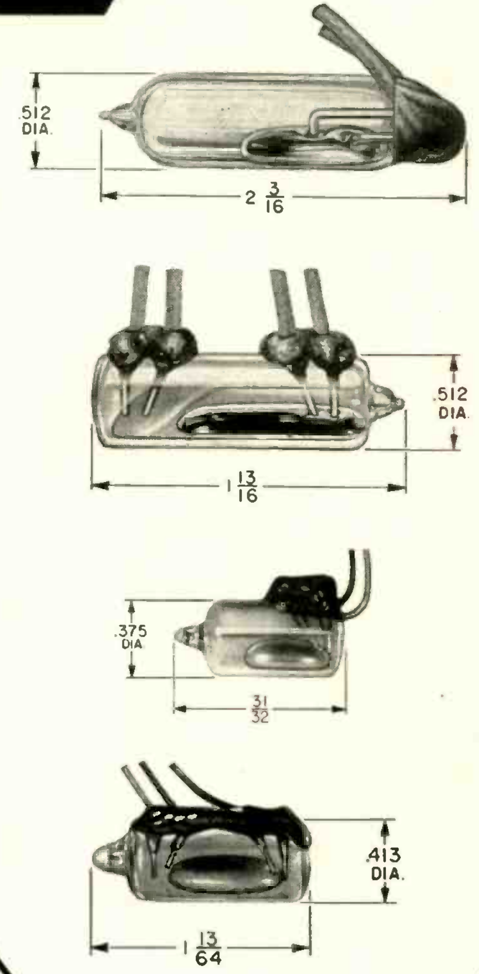
THE ELECTRO MOTIVE MFG. CO., INC. **WILLIMANTIC, CONNECTICUT**

HONEYWELL Mercury Switches

A PRINCIPLE OF GOOD DESIGN



These sensitive MERCURY SWITCHES have differentials as low as ¼°

Many mercury switch applications such as narrow temperature differential controls, leveling devices and pumping controls call for extremely sensitive, low-angle actuation.

The switches shown here are versatile switches designed to meet this type of sensitive service. Some of them provide differential angles as low as ¼ degree.

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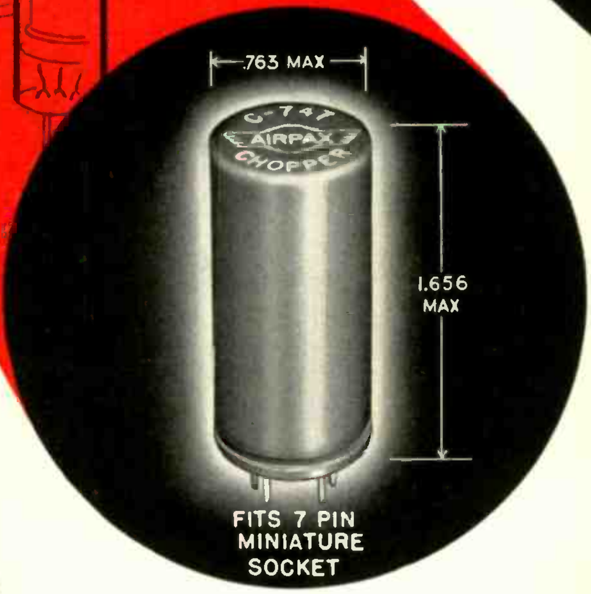
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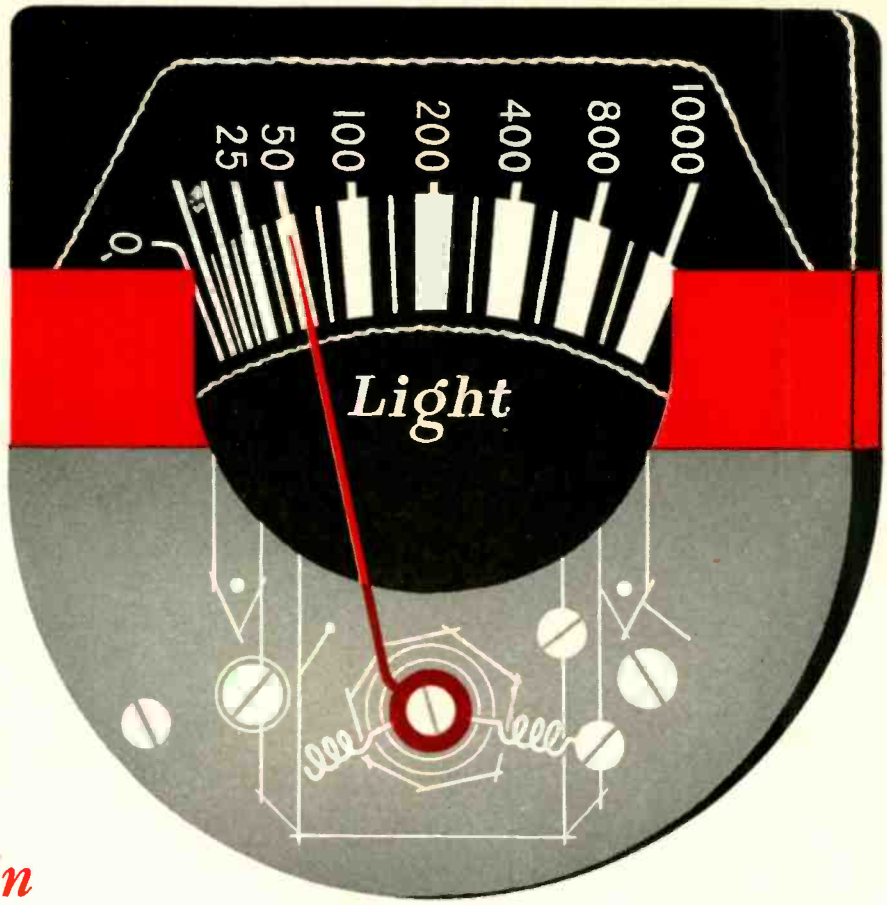

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A MESSAGE TO AMERICAN INDUSTRY • SECOND OF A SPECIAL SERIES

FINANCIAL AID TO HIGHER EDUCATION

What Business Can Do to Help Our Colleges and Universities

Is the financial squeeze now gripping our colleges and universities grave enough to warrant direct action by the business community? If so, what can business do about it? This editorial is addressed to these two questions.

In the previous editorial in this series of two, it was demonstrated that **our colleges and universities, and particularly the independent institutions, face financial difficulties, which, unless relieved, promise to get progressively worse and might ultimately result in a national disaster.** This state of affairs obviously gives the business community a crucial stake in helping to relieve the plight of these institutions. For our business organizations can be no stronger than the total community of which they are a part.

It does not follow automatically, however, that every business firm should give direct financial aid to education. Already the business structure is heavily burdened with activities unrelated to its main purpose. These include acting as tax collector for more than $65 billion of federal, state and local taxes in the year 1953. There is a limit to the amount of such public enterprise that can be loaded on the business system.

Business Holds Key to Answer

If, however, the survival of a key part of our educational system depends on its having financial help from the business community, that help should be provided. And this is the situation of our independent privately endowed colleges and universities.

Of course, our tax-supported institutions of higher learning must also be kept strong, financially and otherwise. But they have recourse to public support not available to the independent institutions. Largely on this account, their present financial difficulties are much less acute than those of the independent colleges and universities.

These independent institutions have seen price inflation eat away much of the value of their endowments. Moreover, there is no prospect that these endowments can be sufficiently replenished by gifts from the wealthy people who provided them in earlier years. Progressive income and estate taxes have seen to that. Thus, they are faced not only with a peculiarly acute financial problem, but also one which cannot be solved except by tapping other sources of aid.

Tax Support No Solution

It is conceivable that the independent colleges and universities might solve their financial problem by seeking support from tax revenues. If they did this, however, they would lose their distinctive character as independent institutions, and our system of higher education would lose one of its major elements of strength. That is the existence in our educational system of both independently financed and tax-supported colleges and universities. Each has its special contribution to make to a well-balanced system of higher education.

Business is directly dependent upon higher education to staff its increasingly complex and exacting operations. A key part in this process is played by the small, independent liberal arts colleges which are the hardest hit financially of all our institutions of higher learning. "These," states the Council for Financial Aid to Education, recently formed by a group of business leaders, "have contributed a high proportion of the intellectual, scientific and religious, as well as business leadership of the nation. Their programs are devoted to the teaching of values, particularly the values of freedom. They are a vital bulwark to our system of free enterprise."

Means of Providing Help

There are many means by which business firms can extend help to our colleges and universities. The most obvious, of course, is to make outright grants of money either to individual institutions or to groups of institutions for such uses as the institutions think best. Another means of help, increasingly employed by business firms, is to establish scholarships to pay the full cost of college or university courses of study. Sometimes the scholarships are open for general competition, sometimes they are limited to employees and children of employees of the firm granting them. Not infrequently those winning the scholarships spend some part of their school vacations working in the companies granting the scholarships.

A number of companies have recently provided for what have come to be called "scholarships in reverse." These companies pay a flat sum to a college or university for every one of its graduates they employ. Financing of university research programs also offers a broad avenue for financial aid to our universities by business.

Need Two-Way Communication

Some business firms have well-developed programs for financial aid to education. But they are exceptional. For most companies the problems involved are new and strange. These companies were created with the basic purpose to make money, not to give it away. Successful philanthopic operations involve a whole set of problems with which they have very little experience. Not the least of these is how to make business a dependable source of financial aid to education, since business has no assurance that the profits of one year will not be losses the next.

Considerations such as these emphasize the wisdom of a recent Industry-College Conference on aid to higher education by business, in making the first of its ten conclusions that "better communication, by direct contact, is needed for each [industry and the colleges] to understand the problems of the other." At this juncture the creation of mutual understanding is much more important than the raising of some money and letting it go at that. The problem of aid to education by business has its immediate urgency, but there is also a long-range program to be developed on which business and the colleges and universities must pull together in the years ahead to find a satisfactory solution.

As stated at the outset, failure to find a satisfactory solution could result in a national disaster. This means that, **to give proper heed to their own future prosperity and the future welfare of the nation, business firms generally must go to work on the problem of financial aid to higher education. They must go to work first, to understand the problem; second, to establish two-way communication with our colleges and universities about it; and third, to develop a program which pays proper heed to the needs and capabilities of both business and higher education.**

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments that are of particular concern to the business and professional community served by our industrial and technical publications.

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Donald C McGraw

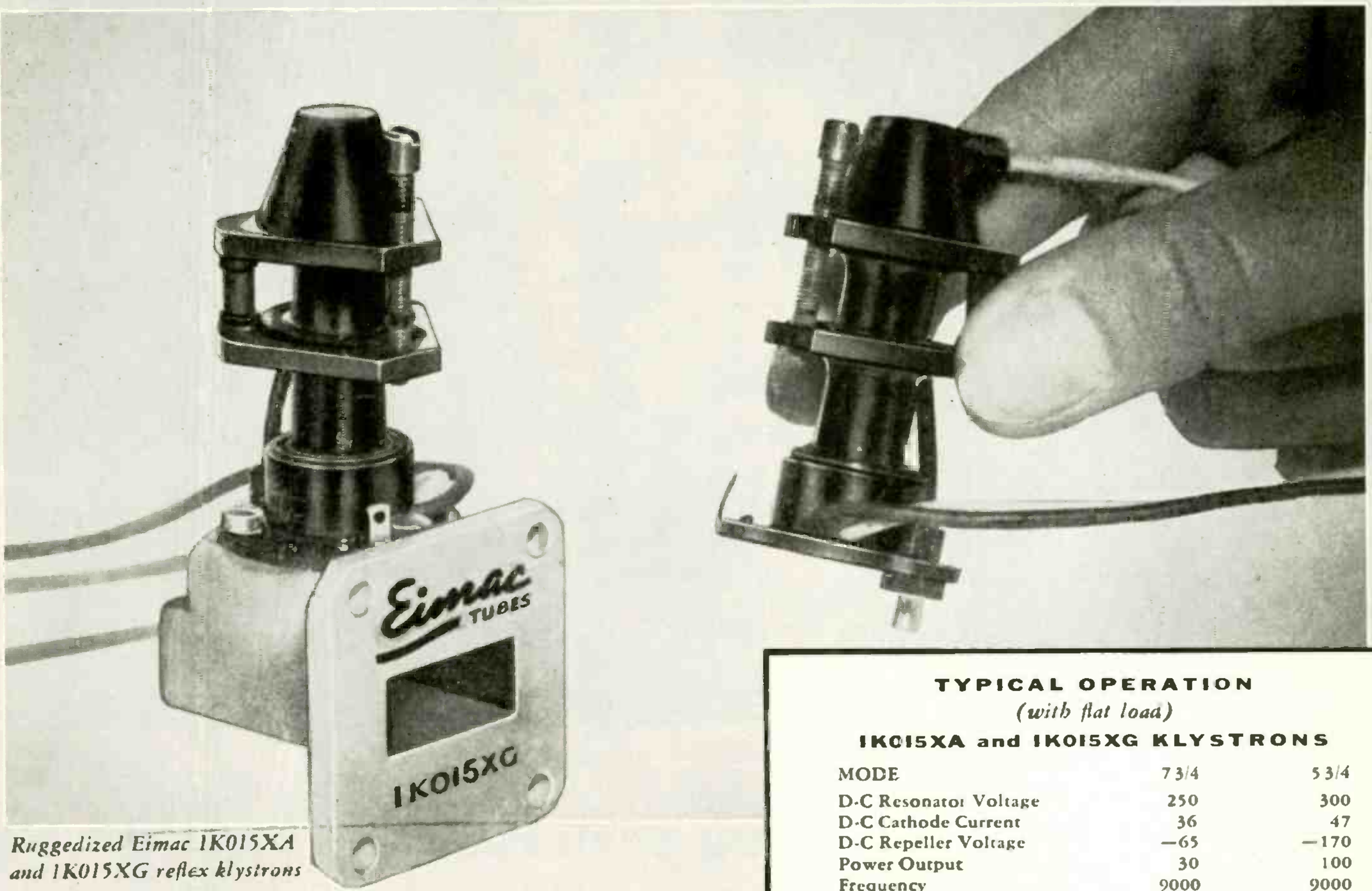
PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.

Eimac Klystron Report

1K015XA • coaxial output
1K015XG • waveguide output

Ruggedized X Band local oscillator reflex klystrons



Ruggedized Eimac 1K015XA and 1K015XG reflex klystrons

TYPICAL OPERATION
(with flat load)
1K015XA and 1K015XG KLYSTRONS

MODE	7 3/4	5 3/4
D-C Resonator Voltage	250	300
D-C Cathode Current	36	47
D-C Repeller Voltage	−65	−170
Power Output	30	100
Frequency	9000	9000
Electronic Tuning Range	55	40

Reliable X band performance through the **VAST*** punishment of airborne environment plus the features of single adjustment tuning and rapid production are offered only in Eimac 1K015XA and 1K015XG local oscillator reflex klystrons.

***VIBRATION**—withstands 10G's of continuous vibration.

***ALTITUDE**—arc-guard protection of leads eliminates possibility of flash-over at extremely high altitudes.

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RAPID PRODUCTION—simplified design permits rapid, low cost production.

RELIABLE PERFORMANCE—25 to 100 milliwatts power output from 8400 to 9600mc with low power consumption—plus assurance of uncompromising Eimac quality proved through 20 years of electron-power tube design and manufacture.

SINGLE TUNING—one-adjustment tuning without the use of lock nuts.

● *For further information about the 1K015XA, 1K015XG or any of the complete line of Eimac klystrons, including high power UHF-TV amplifiers, contact our Technical Services department.*

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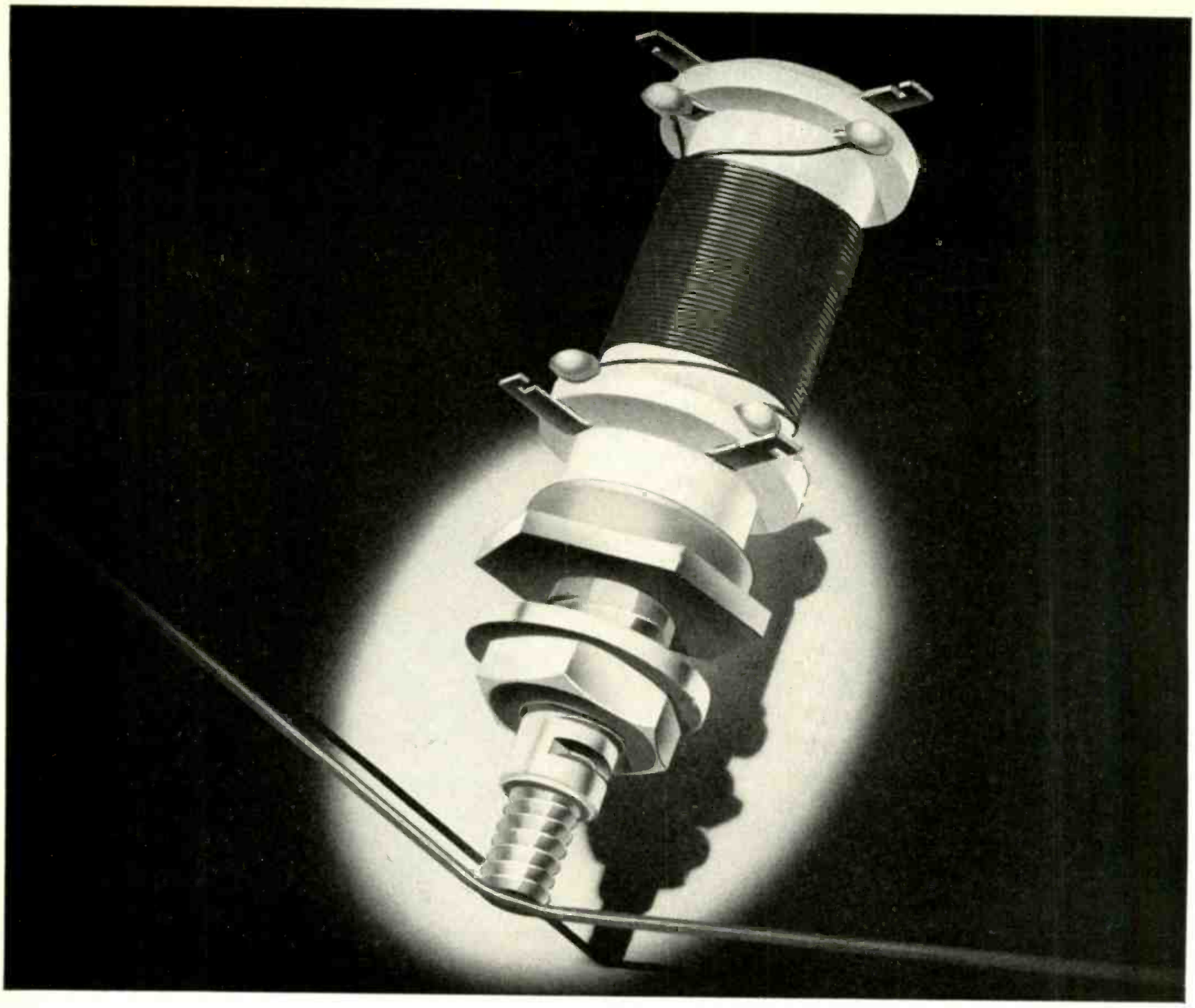


Death-defying performance

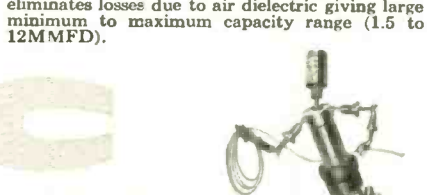
You can depend on C.T.C. coils to give a steady, star performance. They won't go dead despite threats of temperature, climate or vibration. And for very good reasons —

The mounting stud of every C.T.C. coil is fastened to the ceramic body in a special way that does away with weaknesses of ordinary coil fastenings. This special fastening makes C.T.C. coils vibration-proof. What's more, their tightness is preserved in hot, cold, dry or damp weather. All C.T.C. coils are precision-made, of course, to meet individual specifications — and to meet, or better, government specifications, as well. And continuous quality control is maintained.

As a result, you get a *guaranteed* electronic component — custom or standard — whose performance you can depend upon.

Precision-made C.T.C. components that benefit from C.T.C. high quality standards include terminals, terminal boards, capacitors, swagers, hardware, insulated terminals and coil forms. For all specifications and prices, write Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West Coast manufacturers contact: E. V. Roberts, 5068 West Washington Blvd., Los Angeles 16 and 988 Market St., San Francisco, California.

Slug Tuned Coil Data: Single layer or pie type windings to your specifications. Forms of quality paper base phenolic or grade L-5 silicone impregnated ceramic. Mounting studs are cadmium plated brass; ring type terminals are silver plated brass. All units include slugs and mounting hardware. One style (Type C) available with retaining collars of silicone fibreglas which permit 2 to 4 terminals. Windings can be coated with resin varnish, wax or lacquer.



New CST-50 variable ceramic capacitor surpasses range of capacitors many times its size. Stands only 19/32" high when mounted, is less than ¼" in diameter and has an 8-32 thread mounting stud. A tunable element of unusual design practically eliminates losses due to air dielectric giving large minimum to maximum capacity range (1.5 to 12MMFD).

CTC

CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components,
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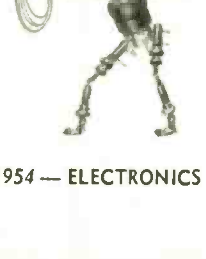

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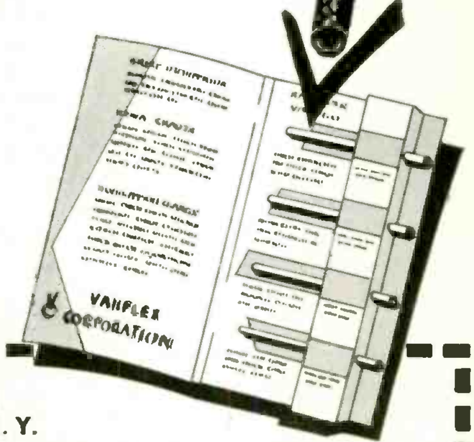
Nothing on the market today excels the low priced Class B protection of Varflo Tubing and Sleeving

Flexible Varflo is solvent-, oil-, moisture-, flame-, and fungus-resistant. Passes the NEMA heat endurance test of 15 minutes at 225°C. Also passes 100 hours at 125°C. Will not lose dielectric strength when subjected to severe handling, bending and twisting. Has good shelf life.

Available in Grades A-1 and B-1 tubing and Grades C-1 and C-2 sleeving.

Let us help you with your problem. Describe it in a letter—no cost, no obligation.



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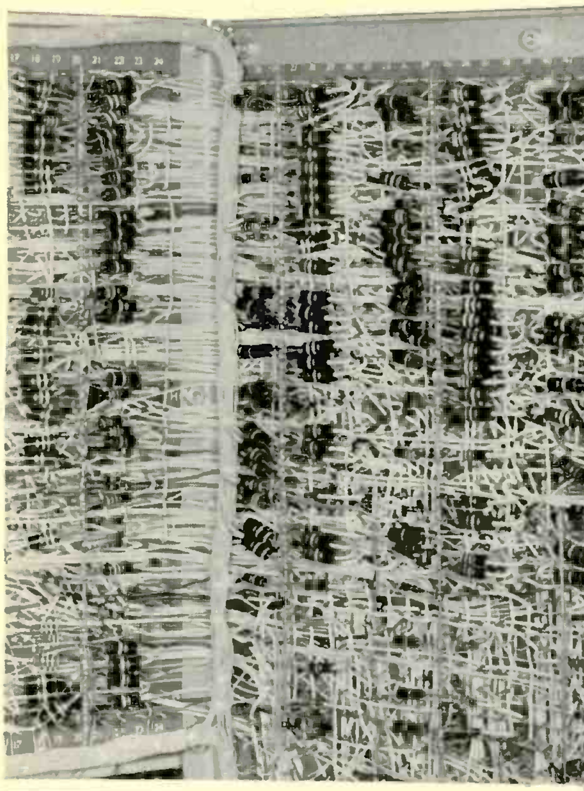
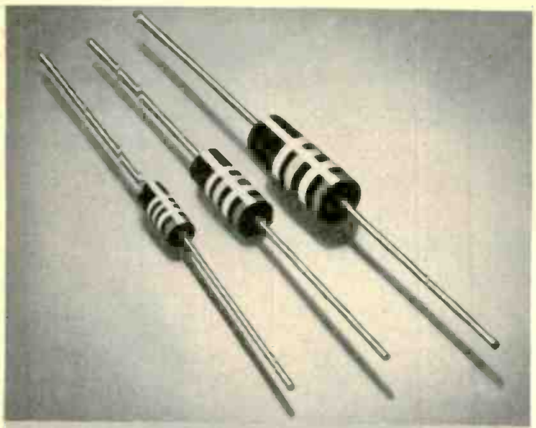


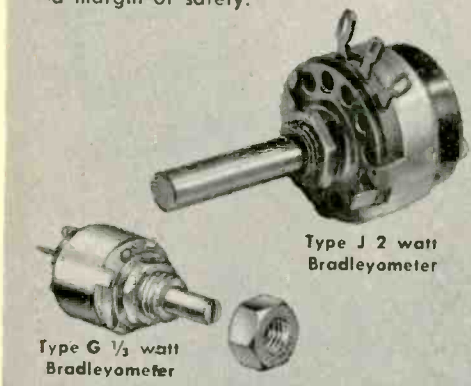
BACK OF DIODE BOARD showing Bradleyunit Resistors

At the left is a rear view of a portion of the complex circuitry of the diode board in the CRC 102A general purpose computer. Several hundred Allen-Bradley Bradleyunits are visible. Their dependable characteristics are necessary for the continuous accuracy of this computer.



High Quality Fixed Resistors

Bradleyunits are rated at an ambient temperature of 70C . . . not at 40C . . . giving them an ultra-conservative rating. No other molded fixed resistors have such a margin of safety.



High Quality Adjustable Resistors

Bradleyometers incorporate a composition resistor molded to the resistance-rotation curve that is specified. They are unaffected by temperature or humidity.

CRC HIGH RELIABILITY COMPUTER
relies on Bradleyunit Fixed Resistors

The CRC 102A general purpose computer, made by the Computer Research Corporation of Hawthorne, California, is a versatile digital computer consisting of a computing unit and a control console which may be used with a variety of input-output equipment. It can perform 25 different arithmetic and logical commands in less than 15 milliseconds. As many as 80 complete 3-address commands can be executed per second. Such performance demands precision and dependability of all components.

Bradleyunit fixed resistors are standard equipment on the CRC 102A, and many other computers, because they are so conservatively rated. They will operate at full rating for 1,000 hours with less than 5 per cent resistance change, because they are rated at 70C . . . not 40C. They withstand heat and humidity, and have high mechanical strength.

Bradleyunits are solid molded with their leads imbedded in the densely compacted body of the resistor. No wax impregnation is needed to pass salt water immersion tests. The differential tempering of the leads prevents sharp bends near the resistor. They are made in all standard R. E. T. M. A. values in the ½ watt and 2 watt ratings from 10 ohms to 22 megohms, and the 1 watt rating from 2.7 ohms to 22 megohms.

Let us send you a complete Allen-Bradley resistor chart.

Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wis.

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To make sure of proper operation under all service conditions, every BUSS fuse normally used by the Electronic Industries is tested in a sensitive electronic device that rejects any fuse that is not properly constructed, correctly calibrated and right in all physical dimensions.

And there's no need to sacrifice quality on any type of fuse, for BUSS offers a complete line of fuses to the Electronic Industries: — standard type, dual-element (slow blowing), renewable and one-time types . . . in sizes from 1/500 ampere up.

On special problems of electrical protection, let BUSS save you engineering time and money. Just send us your specifications and the world's largest fuse research laboratory and its staff of engineers will help you in selecting the fuse best suited to your needs — and if possible, a fuse that is already available in local wholesalers' stocks.

For more information mail this Coupon ▼

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TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
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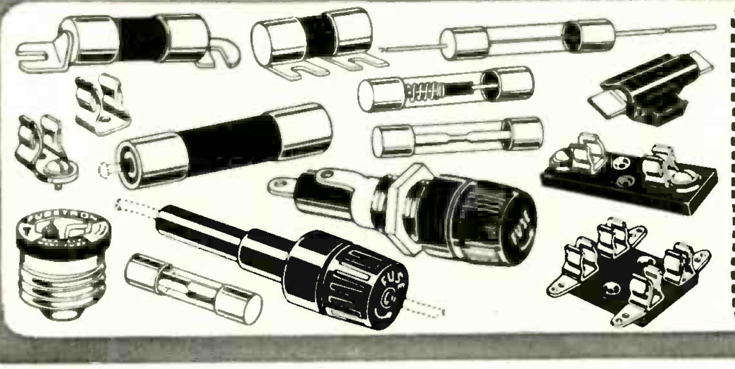

BUSSMANN Mfg. Co.
(Division of McGraw Electric Co.)
University at Jefferson, St. Louis 7, Mo.

Please send me bulletin SFB containing facts on BUSS small dimension fuses and fuse holders.

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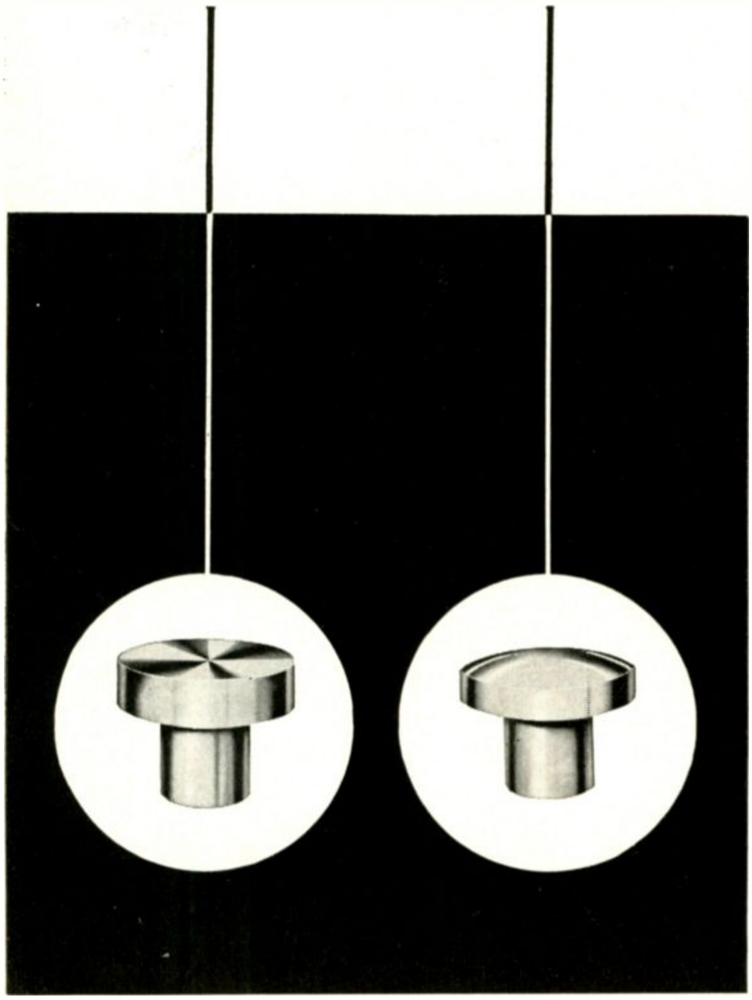
Avoid delivery delays . . . save money . . . with

MALLORY

STANDARD STOCK

Silver Rivet Contacts



Next time you design or order fine-silver headed rivet contacts, check through the list of standard stock Mallory types and sizes. Out of the 70 different sizes and styles of contacts that Mallory carries in stock for immediate shipment, you'll probably find one that fits your exact requirements.

By using standard stock Mallory contacts, you can save time and money in several ways:

SAVING: in time and cost of special designs and tooling

QUICK SHIPMENT: orders from stock are usually shipped within 24 hours.

SAMPLES: immediately available, where necessary.

SMALL QUANTITIES for pilot runs and job orders are delivered promptly.

Mallory's contact standardization program was the result of an intensive survey of thousands of customer prints and usage records. From an analysis of these, 70 sizes were selected which match the great majority of applications for fine-silver headed rivet contacts, in both flat and radius-faced designs.

Dimensions, part numbers and prices of Mallory stock contacts are listed in a new folder. Write for your copy today . . . and use it as a "preferred list" for present and future specifications.

Special Contacts

If unusual requirements call for a contact outside of the standard list, Mallory engineers are well qualified to recommend a specialized contact design. At your service are Mallory's wide range of contact materials, and efficient facilities for manufacturing contacts and complete contact assemblies.

Expect more . . . Get more from **MALLORY**

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electronics

W. W. MacDONALD, Editor

JULY • 1954

CROSS TALK

▶ **MILITARY BUSINESS . . .** A Washington source for whose predictions we have considerable respect says the dollar value of electronic equipment shipped to the military in the fiscal year beginning July 1 will be up about 2 percent over last year. Our informant has been accurate within 1 percent on similar prognostications.

If this one is right, military business will be up more than 2 percent in units despite rising production costs because the Department of Defense is obviously wielding a much sharper pencil on prices than has been the custom since Korea.

The 2-percent figure may seem low to some military people and high to some government contractors but it should be remembered that both have fallen into the habit of thinking in terms of orders placed rather than orders shipped. We'll bet on it, even discounting any increase that might occur because of the worsening international situation.

▶ **UHF TV . . .** The nation's capital is full of suggestions for making uhf television broadcasting pay. There are so many suggestions, in fact, that we refrain from further muddying the water with more and list instead a few things that should be kept in mind in any approach:

When the freeze was lifted many applicants assumed that granting of a station license insured financial success in any market, of any size, anywhere; this just isn't so.

Competition is inherent in the broadcasting business in this country and should be neither legislated in nor legislated out; it should be fair, open competition.

People not now served, or inadequately served, do not care whether they get their pictures via vhf or uhf just so they get good programs; frequencies are mere numbers on a knob to the public.

More stations are needed to provide a national television service comparable to radio. The FCC says that most of these stations will have to be on the ultrahigh frequencies to avoid serious interference. If this is so then licensees will come and licensees will go, but the number of successful uhf stations will slowly but surely increase.

Where the need for a service exists someone always finds a way to make money supplying it.

▶ **ENGINEER-EXECUTIVES . . .** Our *Backtalk* columns are freely offered to anyone who cares to comment on a recent statement by R. F. Pearse before a technical society in Chicago.

Said Dr. Pearse, who is sincerely interested in developing executives for the future: "Personality traits common to engineers are (1) insistence on always being right, (2) hostility toward authority, (3) avoidance of close inter-personal relationships and, (4) limited effectiveness in getting results through others."

True, in general, or not?

▶ **ANOTHER EXTRA . . .** In this issue is the second of three editorial "extras" promised (p 129, Jan.) for 1954.

Beginning on the next page is an article analyzing recent trends in the design of fixed capacitors. Similar articles covering other basic components such as variable capacitors, fixed resistors, potentiometers and transformers will follow during the year.

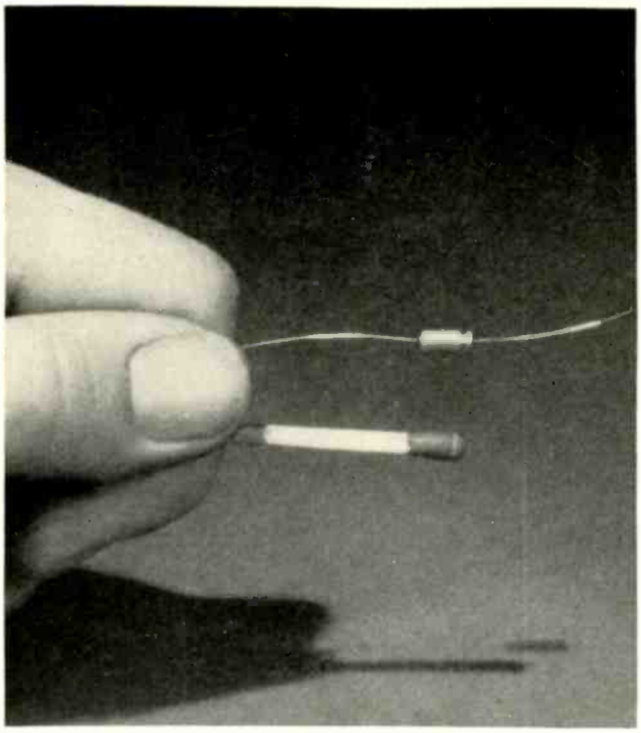
Electronics is primarily a business of assembling components made by somebody else. Components are becoming smaller, lighter, more efficient and more reliable under increasingly severe conditions of shock, temperature and humidity.

Just keeping up to date is a difficult job for engineers. Our new article series has been written to order to simplify this job

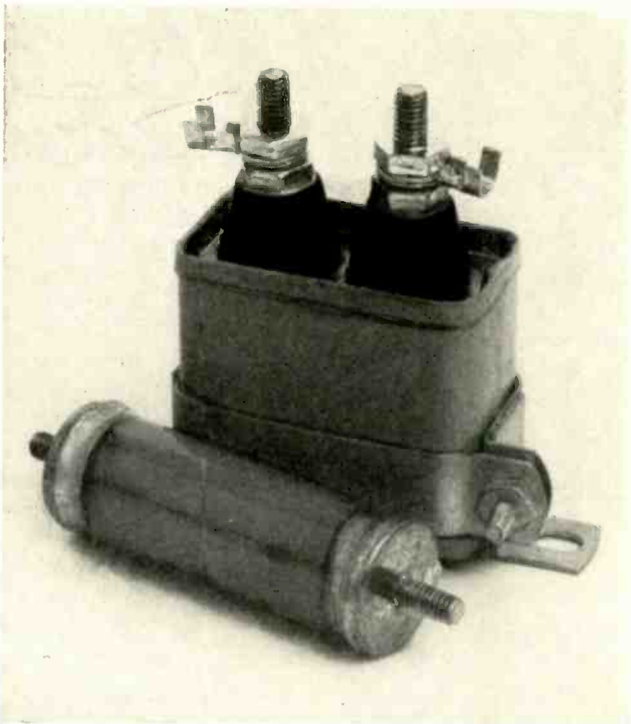
COMPONENT DESIGN TRENDS

FIXED CAPACITORS

Part I of a series that will interpret recent developments for each basic component in the field of electronics. With capacitors, emphasis today is on temperature problems associated with use of new materials and techniques giving more capacitance in less space



Microminiature tantalum electrolytic capacitor made by GE, showing small size as compared to match head. Rating is 8 microfarads at 4 dcwv, as required for use in many transistorized circuits



Plastic-dielectric capacitor with glass housing, made by Carson Electric, is half the size and weight of comparable conventional 0.1 microfarad, 1,000 dcwv oil-filled paper capacitor in background

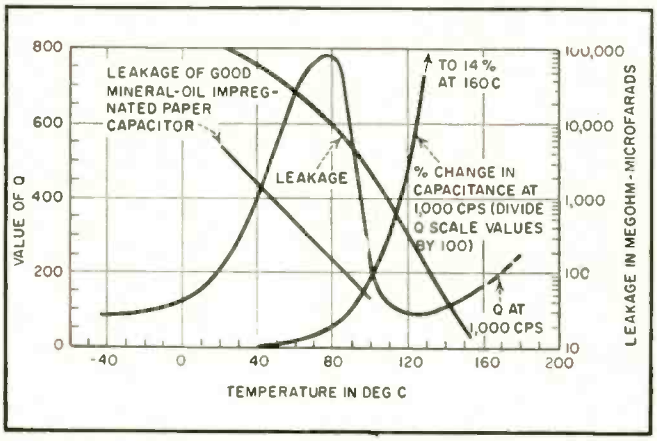


FIG. 1—Representative characteristics of Mylar film capacitors as function of temperature, with paper capacitor curve for comparison

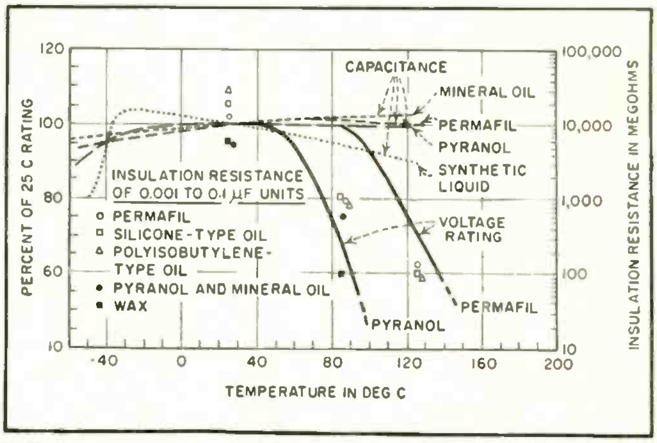


FIG. 2—Temperature characteristics of four representative types of impregnated paper capacitors, as obtained from published GE data

By FRANK ROCKETT

Research and Engineering Division
Airborne Instruments Laboratory
Mineola, N. Y.

Undergo Miniaturization

TRANSISTORS, printed wiring, airborne electronics and guided missiles are just a few of the reasons why there is pressure on design engineers today to squeeze their component parts into less and less space. But miniaturization alone isn't enough for most of these applications; operating temperature, humidity, and a host of other factors also become important in varying degrees according to the conditions of use.

Reduced size has advantages that counteract to some extent the difficulties it introduces in capacitor fabrication and circuit wiring. The amount of material used is reduced; weight is decreased. On the other side of the ledger, the surface area available for heat dissipation is reduced. As a consequence, miniaturized equipment is being required to operate at high temperature. Thus, of all the recent trends in capacitor design, perhaps the one of greatest interest is the effect of temperature.

To present data on a variety of capacitors in a comparable manner, characteristics are plotted here against temperature with an abscissa extending from −60 C to 200 C. These limits seem to set about the widest realistic temperature range over which contemporary electronic equipment can normally be relied upon.

Plastic Dielectrics

Such new resins as the silicones, styrene-polyesters and epoxies were developed to meet the need for high-temperature operation. The silicones are finding greatest use in capacitors as sealants because they retain their low surface leakage even at high humidity. Styrene-polyesters are used for supports.

One of the significant advances in capacitor design is the development of a polyester dielectric film. Produced by E. I. du Pont de Nemours & Co. under the name Mylar, this film retains its high insulating properties from −65 C to 125 C. In addition, the film has high mechanical strength, long-term resistance to heat and chemical inertness if hermetically sealed and dry; the film can be vacuum-metalized with aluminum and thereby used in capacitors that are free of internal voids.

Mylar (polyethylene terephthalate) is used alone or as a laminate with paper for capacitors.

In thin films, Mylar is impregnated with polystyrene, silicone or mineral oil to fill pinholes. Alternatively, several thin films are laminated to cover pinholes. It may well rival paper for use as a general-purpose dielectric where insulation resistance, temperature coefficient of capacitance and operating temperature range are dominant factors.

Some of the characteristics of Mylar are shown in Fig. 1. The dissipation factor is a minimum at about 80 C at 1,000 cps and at 1 mc. At frequencies above 1 mc, the dissipation factor is relatively independent of temperature. The dielectric constant is in the order of 3 and is relatively constant with frequency; although the temperature coefficient of capacitance rises rapidly above 80 C, at normal operating temperatures it is lower than most commonly used dielectrics. (A dielectric constant of 5 is common in chlorinated-diphenyl paper capacitors.)

The dielectric strength, which decreases with increase in temperature, is a function of the thickness of the film. For instance, a 0.25-mil film exhibits a dielectric strength of around 750 volts per mil; a 7-mil film withstands an instantaneous voltage equivalent to 2,800 volts per mil. However, dielectric fatigue results from operation under appreciable internal a-c corona. The film is attacked in air to some extent by corona at 300 to 400 volts rms. The film is, therefore, used in sealed capacitors.

For operation at high potentials, the film should be impregnated with oil or varnished. Capacitors can be operated to temperatures of 125 C with no voltage derating. One such precision capacitor, marketed by Southern Electronics of Burbank, Calif. under the trade name of Mycon in capacitances up to 10 μf and tolerances down to 1 percent, has rated voltages as high as 25,000 volts d-c for a temperature range of −65 C to 125 C. The insulation resistance at 25 C is 100,000 megohms in this capacitance range; at 125 C it is 3 megohms. The dissipation factor of these capacitors is in the vicinity of 0.03 percent.

A growing application for the new film is in low-voltage units for use with transistors. Because transistors are normally limited to temperatures below 75 C, the advantage of the dielectric is chiefly in reducing size; toward this objective, the producer is experimenting with 0.1-mil film.

Considerable saving in space and weight is made possible by a plastic dielectric. The particular unit pictured uses a cellulose-acetate dielectric impregnated and filled with silicone in a tubular construction. The glass housing provides a long leakage path, enabling such units to operate at as high as 60,000 volts; the glass housing hermetically seals to the metallic ends.

Paper Dielectric

A conventional dielectric for fixed capacitors has been paper. The paper serves as a carrier for various

COMPONENT DESIGN TRENDS

- **Impregnating thin Mylar films with polystyrene, silicone or mineral oil to fill pinholes**
- **Metallizing Mylar films in vacuum with aluminum**
- **Using glass housings for high-voltage sealed capacitors**
- **Impregnating paper with a solid resinous material such as Permafil to boost temperature limits and reduce size**
- **Improving temperature ratings of metallized paper capacitors by using a chemically inert copolymer as impregnant**
- **Forming electrolytics at high current density to improve energy storage performance**

types of impregnants which by themselves may lack mechanical stability, especially at high temperatures. Among the more common impregnants are vegetable oil, mineral oil and synthetic insulating liquids. A more recent impregnant, known by the GE trade name Permafil, is a solid resinous material that retains its electrical characteristics at temperatures as high as 125 C ambient rating. Because of this characteristic, capacitors made with Permafil are appreciably smaller than equivalent paper-dielectric capacitors.

A comparison of operating voltages for paper capacitors with oil-impregnated and Permafil-impregnated capacitors is shown in Fig. 2. Where alternating voltage is present in addition to direct voltage, the operating voltage determined from the curves applies to the sum of the direct voltage and the peak alternating voltage. However, the peak alternating voltage should not exceed 20 percent of the direct voltage at 60 cps or 1 percent at 10,000 cps. That is, such units are engineered for use primarily as decoupling and blocking capacitors. In low-frequency RC oscillators and related predominantly a-c applications paper capacitors are used conservatively.

Because leakage current is of great importance in many electronic applications, this characteristic of capacitors is frequently used as a measure of the quality of a capacitor. Paper-dielectric capacitors impregnated with Permafil have a leakage of over 4,000 megohm-microfarads at 25 C, over 100 megohm-microfarads at 85 C and over 8 megohm-microfarads at 125 C. The variation in capacitance of these capacitors with temperature is also shown in Fig. 2.

Where high-temperature operation is not required, Pyranol capacitors can be used. Pyranol is a liquid impregnant with high dielectric constant that makes possible smaller paper-type capacitors. At −55 C, these capacitors lose no more than 15 percent of their 25 C capacitance. Thus, such capacitors have much the same characteristics as wax-filled capacitors of identical size but permit operation of equipment to lower temperatures.

For protection against humidity, especially where equipment operates through a wide temperature cycle and is thereby made to breathe appreciably, capacitors are hermetically sealed. A silicone bushing provides a rugged and permanent liquid-tight seal with generous air strike and creepage distance that is resistant to vibration and shock. The silicone bushing permits operation at rated voltage under severe humidity and high altitudes (50,000 feet). Because the hermetic seal also prevents the entrance of potting compound, capacitors so sealed can be used in potted circuits provided the pour temperature does not exceed the peak operating temperature for the capacitor.

Impregnated paper capacitors should be applied with caution when either the a-c or d-c voltage is less than about 10 volts, because some pressure contacts require appreciable current to maintain their low resistance. Some low-voltage capacitors are made with an extended foil or a webbed-flag tab in which a metal strip is welded to the tab to increase the area of contact with the foil as much as ten times.

As with plastic-dielectric capacitors, the reliability of paper capacitors depends greatly on moisture-tight seals at seams and terminals, impregnants and other materials that are chemically inert toward each other and mechanical stability.

Metallized Paper

In the late '40s, metallized paper capacitors attracted widespread interest because of their compactness and because, when electrically punctured, the electrodes quickly evaporated in the vicinity and thereby prevented the formation of a short. Experience soon indicated, however, that such capacitors were limited to rather low temperatures (below 65 C), partly because of deterioration of the impregnant in the vicinity of a point of failure.

Considerable improvement has resulted from the use of Aerolene as an impregnant; it is a copolymer of a polyester and a styrene-monomer that can be polymerized without producing water and is considerably more inert chemically than conventional impregnants, which is especially important in metallized capacitors. Capacitors made with Aerolene can be operated from −55 C to 100 C without derating and up to 125 C if derated 25 percent. Their capacitance increases about 0.1 percent per deg C. Insulation resistance falls from some 2,000 megohm-microfarads at 25 C to about 2 megohm-microfarads at 125 C.

Electrolytic Capacitors

Electrolytic capacitors, used heretofore chiefly for low-frequency, low-impedance, bypass and storage functions, now find use in applications that require high pulse energy storage. Examples are photoflash and pulsed circuits. To provide such capacitors with reduced power factor and leakage current, development in Europe is directed toward reducing impurities in the aluminum used for roughened electrodes.

Two principal limitations to aluminum electrolytic capacitors are the formation of a secondary stratum of aluminum oxide dielectric, which is somewhat soluble in acids, and the presence of needle-like crystals of iron oxide semiconductor projecting from the surface of the aluminum anode and occasionally extending through the aluminum oxide dielectric. The soluble secondary stratum of aluminum oxide can be kept to a minimum by forming a capacitor at high current density; the iron oxide crystals can be minimized by using high-purity aluminum. Such capacitors have a representative rating of 500 μf at 500 v, a space requirement of about 0.8 cu cm per μf, a power factor less than 5 percent, and a leakage current less than 0.4 ma. They use electrolytes of high conductivity with the addition of colloids to increase their breakdown potential. A particular advantage of this type capacitor in pulsed circuits is the stability of the cathode so that, in the event of a sudden discharge, there is less likelihood of the cathode being formed.

The widespread use of selenium rectifiers has placed a further requirement on electrolytic capacitors. Because of their low forward resistance, selenium rectifiers subject the first filter capacitor of a rectifier-filter network to very high surges and ripple voltages, which would be limited by the internal resistance of vacuum-tube rectifiers. Also, because the reverse impedance of selenium rectifiers tends to decrease during periods of idleness, high reverse current reaches the capacitor immediately after power is applied to a selenium rectifier and continues until the barrier layer is reformed. For both these reasons, a current-limiting resistor is often placed between a selenium rectifier and a first filter capacitor.

In the presence of high ripple voltages, plain cathode foil capacitors tend to develop an oxide deposit during the negative slope of the ripple voltage. In time this cathode formation, by producing a second capacitor in series with the original anode-dielectric capacitor, will reduce the total effective capacitance of the unit; this loss in capacitance is most pronounced at lower direct voltages. For such operation, it is preferable to use electrolytic capacitors in which both the cathode and the anode foils are etched and formed; that is, nonpolarized a-c electrolytic capacitors.

Tantalum Electrolytics

For units that have high capacitance and are required to operate under severe environmental conditions including a temperature range of −55 C to 200 C, tantalum electrolytic capacitors are commercially available. Figure 3 presents representative characteristics. Tantalum electrolytics are about two-thirds the size of equivalent aluminum electrolytics.

Unlike aluminum electrolytic capacitors, tantalum capacitors are affected very little by idle storage without bias voltage. Such capacitors are conservatively expected to have a shelf life well in excess of ten years, and may even be stored for considerable time at temperatures as high as 85 C, although such storage results in a slightly longer recovery to normal d-c leakage current when the units are first placed in service. Long service life is also expected.

Accelerated life tests being conducted by P. R. Mallory at 125 C ambient and full rated voltage show that tantalum electrolytics on test for two full years are still within the final-inspection electrical limits for new units.

For low-voltage direct-current applications, such as in transistor circuits, a line of microminiature Tantalytic capacitors (trade name used by GE) have capacitances as high as 8 μf and are available in ratings up to 20 v in a case about the size of the head of a wooden match. As an example, a unit $\frac{5}{16}$ inch long and $\frac{1}{8}$ inch in diameter provides 4 μf at 4 dcwv. These capacitors employ a tantalum anode, stably oxidized to the voltage rating, enclosed in a silvered case and impregnated with a nonacid solution to provide a stable electrolyte. A synthetic plug in the end of the case is roll-crimped into place and a solderable tin-coated nickel lead is lap-welded externally to the projecting tantalum anode lead. The tin-coated copper case is the cathode or negative terminal. The unit is thus hermetically sealed.

Superimposed a-c voltages on tantalum capacitors should be small compared to the d-c voltages, just as for aluminum electrolytic capacitors. Initial power factor of these miniature units is about 20 percent; the capacitance is highest in the

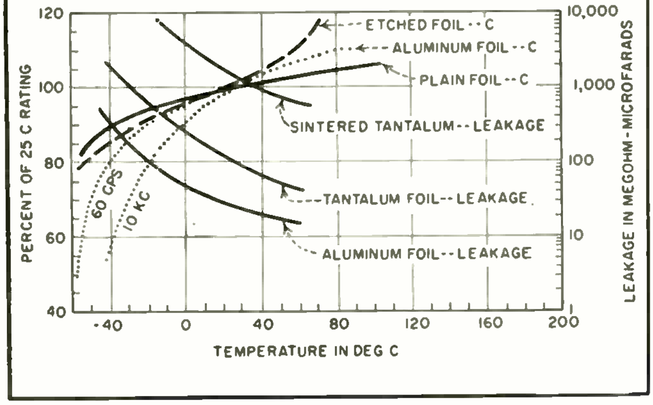


FIG. 3—Comparison of characteristics of aluminum and tantalum electrolytics. Leakage curves are for 30-minute electrification

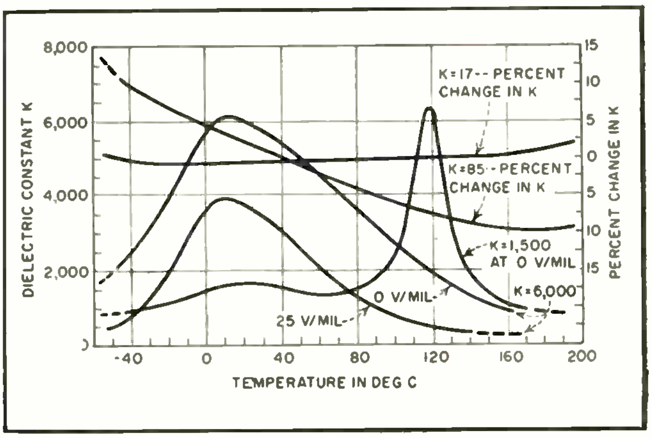


FIG. 4—Temperature characteristics of titanate-base ceramic capacitors, from Glenco Corp. data for representative units

COMPONENT DESIGN TRENDS

- **Developing temperature-stable ceramic mixes using barium titanate**
- **Using bentonite clay derivative as dielectric in high-voltage capacitors**
- **Fabricating high-temperature units in monolithic blocks of vitrified porcelain or glass**
- **Using synthetic dielectrics to get longer time constants than with mica**

vicinity of 25 C. Leakage current at 25 C is about 0.2 μa per μf per volt. These units are rated for operation over a temperature range of −20 C to 50 C, although operation is possible at lower temperatures with a decrease in capacitance.

Ceramic Dielectrics

The characteristics of ceramic dielectrics can be varied over wide ranges, although individual characteristics cannot readily be varied independently of others; even so, capacitors using ceramic dielectrics have been tailored to a wide variety of applications. Some ceramics have very high dielectric constants at room temperature. In general, however, the higher the dielectric constant, the more temperature-sensitive is the dielectric. Practically all ceramic dielectrics contain a large portion of barium titanate, the dielectric constant of which is voltage-sensitive.

For circuits in which the angular velocity or time constant must remain constant within narrow limits despite wide temperature fluctuations, small fixed capacitors consisting essentially of a ceramic dielectric with silver electrodes fired on at a very high temperature are used. The composition of the dielectric material is varied so that a wide range of temperature characteristics is obtained. One series of ceramic dielectrics includes temperature coefficients of dielectric constants having any predetermined nominal value from +100 to −1,400 parts per million per degree C. These capacitors display a temperature coefficient of capacitance that is definite and entirely reproducible under normal operating conditions. With the silver electrodes in intimate contact with the surface of the dielectric, air spaces or wax-filled pockets between the electrodes and the dielectric are avoided. The curves for $K = 17$ and $K = 85$ in Fig. 4 are indicative of the temperature-compensating characteristics available in such capacitors.

For bypassing functions where a capacitor is required only to present a low a-c impedance, ceramic capacitors are usually used that have the highest possible dielectric constant, even though this may mean considerable variation in capacitance with temperature and voltage as indicated by curves for $K = 1{,}500$ and $K = 6{,}000$ in Fig. 4. This type of capacitor is available in a variety of mechanical configurations to facilitate use in very high frequency circuits.

Where it is necessary to protect ceramic capacitors from humidity or other adverse atmospheres, they are sometimes molded and insulated in low-loss phenolic jackets. The safe upper temperature of operation of such capacitors is limited as much by the behavior of the jacket at high temperature as by the loss in capacitance.

Because of the considerable dependence of dielectric constant on temperature in high-K capacitors, research at Solar Manufacturing Co. and at Erie Resistor Corp. is currently directed toward the development of temperature-stable ceramics. This work has resulted in commercial capacitors having a maximum change in capacitance of 10 percent from −55 C to 85 C, compared to a change of 25 percent heretofore.

By precise control of the manufacture of the ceramic dielectric, starting with raw materials of high purity, stable capacitors with a dielectric constant approaching 1,500 are produced. Such capacitors display a maximum change in capacitance of 5 percent from −55 C to 105 C and no more than a 10 percent change from −55 C to 125 C. Insulation resistance is 10,000 megohms minimum; at 1 kc their power factor is 1.5 percent maximum. Although a principal constituent of these capacitors is barium titanate, they have negligible piezoelectric effect in this application.

A bentonite clay derivative, developed by Aircraft-Marine Products as a possible mica substitute, is thermally stable from −60 C to 200 C. Because of its high dielectric strength (5,000 volts per mil in 1-mil samples), it is used in high-voltage capacitors.

Monolithic Structures

For operation at higher temperatures, capacitances up to 6,800 μμf are fabricated as a monolithic rock-like block composed of vitrified porcelain or high-temperature glass in which silver electrodes are immersed. Although the geometry of the capacitor is orthodox, the intimate bond between the conducting and dielectric materials improves its environmental independence. Figure 5 presents representative data for monolithic capacitors.

An inert porcelain body in this type capacitor results in unusually stable electrical characteristics under varying temperature conditions. The temperature coefficient of capacitance is +120± 5 ppm per deg C. Total change in capacitance from −55 C to 200 C is about 5 percent. The intimate bond between the silver and porcelain does not disturb the thermal expansion properties of the porcelain. Therefore, the capacitor bodies behave thermally as would a block of porcelain having high thermal conductivity. The body expands and contracts as a unit and no physical creep occurs between portions of the structure, so that the physical and electrical properties of the capacitor retrace their characteristic curves essentially in an absolute fashion. Such capacitors are stable over temperature ranges exceeding

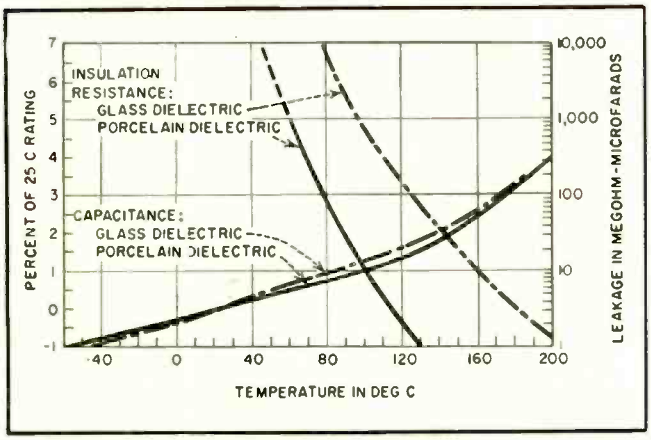


FIG. 5—Comparison of temperature characteristics of monolithic capacitors of glass (Corning) and of vitrified porcelain (Vitramon)

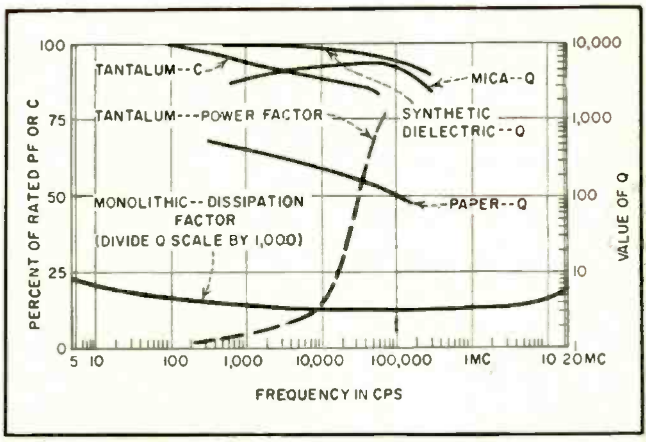


FIG. 6—Frequency characteristics of representative capacitor types using various dielectric materials

the limits of −55 C to 200 C.

Because the silver electrodes of monolithic capacitors are completely immersed in the dielectric, corona starting voltage is considerably above that of units of other constructions and equivalent volume. All corona must be within the dielectric itself since no molecular incompatible materials exist in the structure. Dielectric strengths are also entirely a function of the properties of the insulating materials.

The dissipation factor of 0.0003 at 1 mc for the porcelain is maintained through quality control of the dielectric material. The porcelains used in these capacitors have a loss characteristic which displays interfacial polarizations similar to that of mica. Therefore, some increase in loss occurs at very low frequencies, accompanied by a corresponding increase in capacitance.

The self-resonance of a typical monolithic capacitor is comparable to the inductance of a bar of copper with the same geometry as the capacitor body.

The vitrified block of porcelain is not porous, hence these capacitors are immune to atmospheric effects just as are capacitors with glass or porcelain hermetic seals. Furthermore, the entire body is homogeneous, and no change is brought about by chipping off a corner or an edge of a capacitor as long as the chip does not penetrate to the electrode structure. Even so, surface treatments to repel outer surface contamination are commonly used.

The porcelain capacitor withstands unusually high accelerations (units fired in projectiles with accelerations of over 40,000 g have remained undamaged). No change occurs in electrical properties until the unit physically breaks.

For continuous operation at high temperature, glass monolithic capacitors are also used. Structurally they are much like the monolithic porcelain capacitor in that the electrodes are imbedded in the glass body which serves both as dielectric and as cover. In miniaturized circuits these capacitors provide a relatively high capacitance-to-volume ratio; for example, a 500-volt, 150-μμf capacitor has a volume of about 0.005 cubic inch.

The Q of glass capacitors is especially constant. It does not decrease markedly at low capacitances because the case is of the same glass as the dielectric, nor at high capacitances because the direct connection to the foils results in low inductance.

Precision Capacitors

For the stability required in a precision calibrated capacitor, natural mica is still a preferred dielectric material. For greater stability the mica is silvered to eliminate voids between the plates of the capacitor and the dielectric. One such capacitor, manufactured by Leeds & Northrup Co. for use in its decade capacitance boxes, is hermetically sealed, has a maximum safe operating voltage of 500 volts, a maximum insulation resistance exceeding 5,000 megohms and a dissipation factor less than 0.0001. The phase angle, as mounted in a decade box, of units having a capacitance in the order of 0.1 μf and 0.01 μf is less than 20 seconds; the phase angle of units having capacitances in the order of 0.001 μf is less than 40 seconds. Maximum safe current is 1 ampere rms. The temperature coefficient of capacitance is less than about +0.016 percent per degree C at normal ambient temperatures.

Capacitors using synthetic dielectrics can, by sacrificing temperature stability somewhat, provide other characteristics that in some cases are superior to those of mica. For example, Industrial Condenser Corp. markets under the trade name of Stabelex D a series of capacitors that, for pulse operation, have a dielectric absorption which is 1/25 that of commercial mica capacitors. For a 10-μf capacitor of this type maintained at normal room temperature and humidity, a time constant as long as 200 days has been measured. These units are hermetically sealed in a lead-coated steel case and have glass standoff terminals. Units are available with capacitances ranging from 0.05 μf to about 10 μf at 600 dcwv. They are manufactured to tolerances of ±10 percent and as accurate as ±1 percent on special order. Normal operating temperature range is from −80 C to 75 C. The insulation resistance at 25 C is 10^6 megohm-microfarads, or approximately ten times that of commercial oil capacitors.

Figure 6 compares the Q of several types of capacitors as a function of frequency.

Equipment designed for nontechnical personnel (left) swings out on hinges for quick servicing in port (right)

Multichannel F-M Aids Marine Communications

New communications plan for Great Lakes shipping eliminates medium-frequency interference problems by using carriers between 156.3 and 161.9 mc. Specialized mobile equipment for shipborne use includes 8-channel switching arrangement

MARINE RADIOTELEPHONE communication is now carried out principally on medium and high-frequency channels between 1.5 and 9 mc. The congestion on these channels has increased to the point where in some areas only a fraction of the desired communication load can be accommodated. This is particularly true on the Great Lakes and on the Canadian west coast. Although the greatest part of such ship-to-ship and ship-to-shore traffic is carried out over distances of less than 50 miles the propagation characteristics of these frequencies is such that interference is regularly experienced from ships hundreds and even thousands of miles away.

A solution to this problem lies in the use of channels assigned to the vhf marine service. These channels, particularly when frequency modulation is employed, have the advantage of providing dependable, noise-free communication over ranges of 50 to 100 miles without interference from cochannel equipments located appreciably beyond line-of-sight range.

Frequencies Available

Present channel assignments are based on a joint agreement between the Canadian and United States governments and are allocated on the following basis:

(1) Frequencies from 156.3 through 157.4 mc and 161.9 through 162.0 mc have been made available for vhf marine service.

(2) Channel spacing at the present is on a 100-kc basis with the center of the first channel being 156.3 mc.

(3) Frequency tolerance is 0.01 percent.

Table I lists the 14 vhf channels available for marine service[1,2] as well as the proposed functions of each channel.

Equipment designed for the vhf marine service must meet a number of requirements not normally encountered in vhf land mobile service. These basic requirements can be enumerated as follows:

(1) Equipment must be capable of operation on a number of alternative channels, a minimum of four being generally accepted as a reasonable compromise between flexibility and cost.

(2) It must be possible to change channels by means of a

Small vessel typical of Great Lakes and Canadian west coast maritime activities requires only small antenna atop mast

By WILLIAM ORNSTEIN
and PETER CAHN

Canadian Marconi Co.
Montreal, Canada

simple switching operation without retuning.

(3) Equipment should be designed to operate with the various primary power sources encountered on ship board. This includes 110 volts a-c, 220 v, 110 v, 32 v and 12 v d-c.

Equipment described below fulfills the needs of this maritime service.

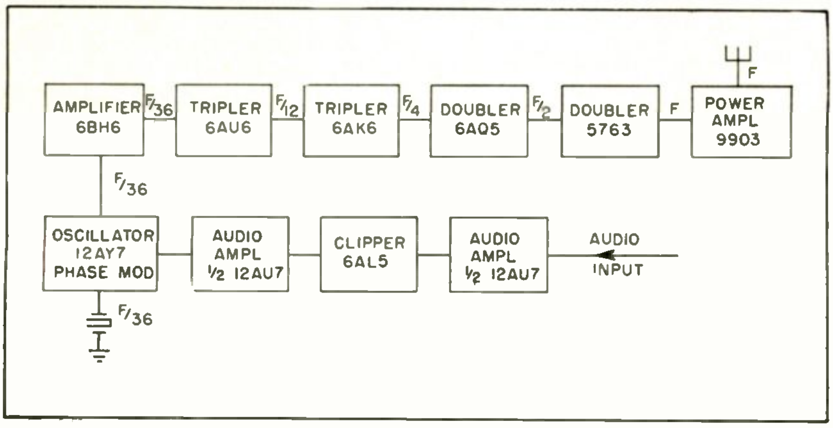
Transmitter

Since all transmitter frequencies are in the range 156.3 mc to 157.4 mc, the transmitter is designed to operate over a bandwidth of 1.1 mc without retuning. Channel switching on transmit therefore requires switching of the transmitter crystals only, as indicated in Fig. 1.

The transmitter is phase-modulated, employing a frequency multiplication of 36. A 5894/AX9903 twin tetrode in the output stage gives a power output of 25 watts over the band. Peak deviation is limited to ±15 kc by a symmetrical clipping circuit. High-frequency pre-emphasis before clipping and de-emphasis after clipping applies modulation limiting mainly to the higher-frequency audio components. In a phase modulation system these components are largely responsible for frequency excursions beyond

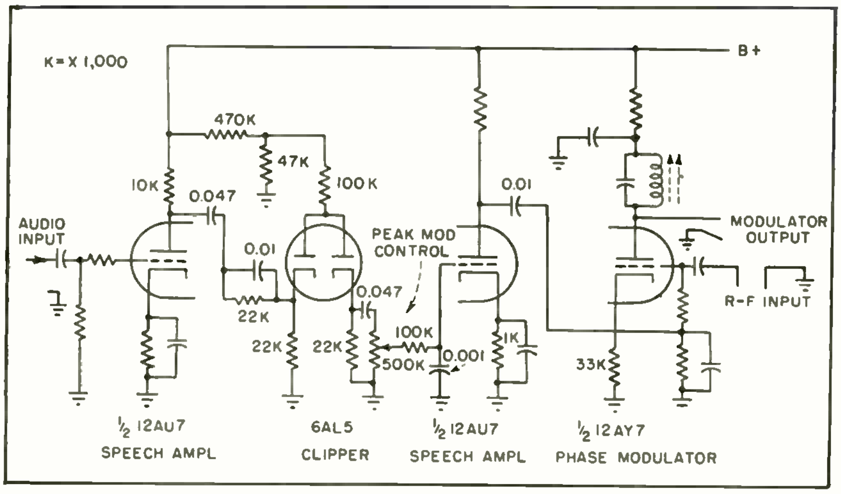
Table I—Great Lakes VHF Supplemental Radiotelephone System

Channel	Frequency in Mc	Function
1	156.8	Safety Calling
2	156.3	General Intership
5	157.0	Second Intership (large vessels)
6	156.7	Third Intership (small vessels)
3	157.2	Coast Guard Working
4	156.6	Port Operations
X	156.5	Large Vessel Operational
7	157.3–162.0	Public Correspondence—duplex
8	157.4–161.9	Public Correspondence—duplex
W	156.9	Tug Dispatch
Y	156.4	Ferries, etc



AMPLIFIER 6BH6
F/36
TRIPLER 6AU6
F/12
TRIPLER 6AK6
F/4
DOUBLER 6AQ5
F/2
DOUBLER 5763
F
POWER AMPL 9903
F
F/36
OSCILLATOR 12AY7 PHASE MOD
AUDIO AMPL 1/2 12AU7
CLIPPER 6AL5
AUDIO AMPL 1/2 12AU7
AUDIO INPUT
F/36

FIG. 1—Block diagram of 25-watt transmitter used in vhf communications

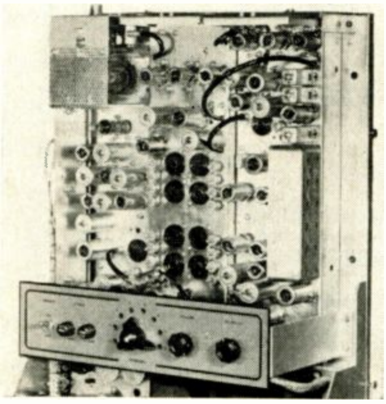


K=X 1,000
B+
470K
47K
10K
0.047
100K
0.01
AUDIO INPUT
0.01
PEAK MOD CONTROL
22K
0.047
100K
500K
0.001
22K
22K
1K
33K
MODULATOR OUTPUT
R-F INPUT
1/2 12AU7 SPEECH AMPL
6AL5 CLIPPER
1/2 12AU7 SPEECH AMPL
1/2 12AY7 PHASE MODULATOR

FIG. 2—Detail of speech amplifier and phase modulator

rated maximum channel value.

Figure 2 illustrates the circuit employed in the clipper and phas-modulator stages. The use of three double-tuned circuits in the transmitter as well as a Faraday shield in the output circuit result in all harmonic and spurious emissions being attenuated by more than 60 db below carrier level.



Removal of dust cover provides access to one side of hinged unit

Receiver channels, unlike those of the transmitter, lie in two bands —156.3 to 157.4 mc and 161.9 to 162.0 mc. The receiver shown in the block diagram of Fig. 3 is a double-conversion superheterodyne with two r-f stages and five tuned circuits at signal frequency before the first mixer. An oscillator-multiplier chain, which supplies an injection signal to the first mixer, contains another four tuned circuits that are signal-frequency dependent.

Receiver Controls

To accommodate the two widely separated frequency bands the first three receiver stages as well as the first oscillator-multiplier chain located on the receiver chassis are duplicated on a frequency control unit chassis. Which of the two receiver r-f heads is actually used is determined by the setting of the channel change switch on the control frequency unit. This switch also controls the operation of a relay that connects the receiving antenna to the receiver r-f head in actual use. From the first i-f stage onward the remainder of the receiver circuitry is common to all channels and is located on the receiver chassis.

The overall receiver selectivity is mainly determined by the lumped i-f filter that follows the second mixer. A minimum of gain is employed prior to the filter to reduce spurious response and ensure against desensitization of the early stages by strong interfering signals on adjacent channels. The principle followed is that of lumping the main selectivity at one point in the circuit at a reasonably low frequency and concentrating the gain of the receiver after this point so that minimum amplification is given to undesired signals. This approach has proved effective.

Tuned Filter

The i-f filter is built into an aluminum casting and employs twelve tuned circuits. Figure 4 shows the circuit arrangement of the filter components and Fig. 5 is a curve of the filter passband with 6-db points at least ±17 kc and 90-db points less than ±40 kc from the carrier frequency. A high-gain broadband i-f amplifier with three amplifier and two limiter stages follows the filter and feeds the discriminator stage, which recovers the original modulation.

The satisfactory performance of this receiver under conditions of weak and fluctuating signal results in large part from careful design of the limiter stages. The limiter circuit shown in Fig. 6 employs two cascaded 6BN6 gated-beam tubes, the second stage being saturated by receiver noise when no signal is received.

Frequency Control Unit

The crystals required for both receiver and transmitter operation are located on the frequency-control unit chassis. When all eight channels are employed, a total of sixteen crystals is required. Each crystal oven is capable of accommodating two crystals so that a maximum of eight ovens may be needed. A small trimmer capacitor is connected

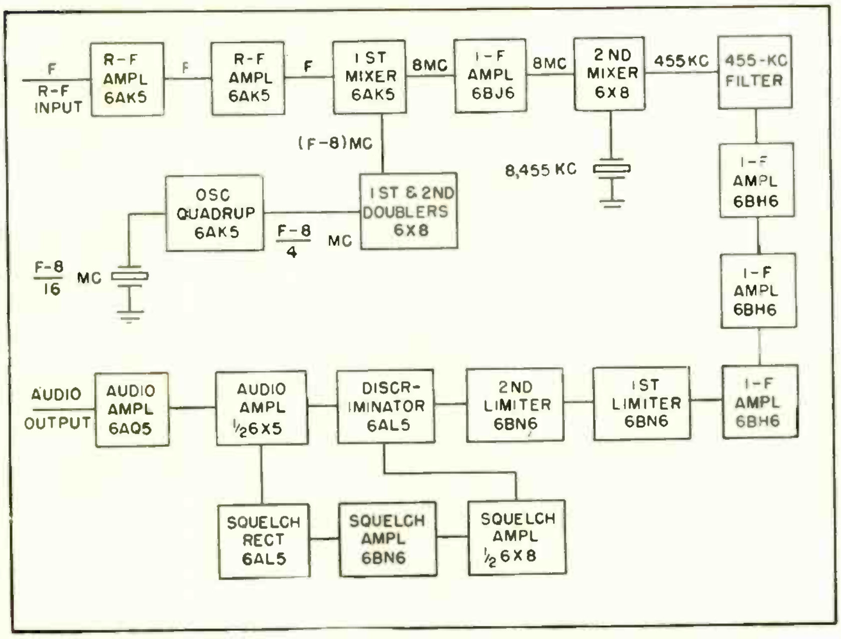

F
R-F INPUT
R-F AMPL 6AK5
F
R-F AMPL 6AK5
F
1ST MIXER 6AK5
8MC
I-F AMPL 6BJ6
8MC
2ND MIXER 6X8
455KC
455-KC FILTER
(F-8)MC
8,455 KC
OSC QUADRUP 6AK5
1ST & 2ND DOUBLERS 6X8
F-8/4 MC
F-8/16 MC
I-F AMPL 6BH6
I-F AMPL 6BH6
AUDIO OUTPUT
AUDIO AMPL 6AQ5
AUDIO AMPL ½6X5
DISCR-IMINATOR 6AL5
2ND LIMITER 6BN6
1ST LIMITER 6BN6
I-F AMPL 6BH6
SQUELCH RECT 6AL5
SQUELCH AMPL 6BN6
SQUELCH AMPL ½6X8

FIG. 3—Block diagram of double-conversion receiver with i-f filter

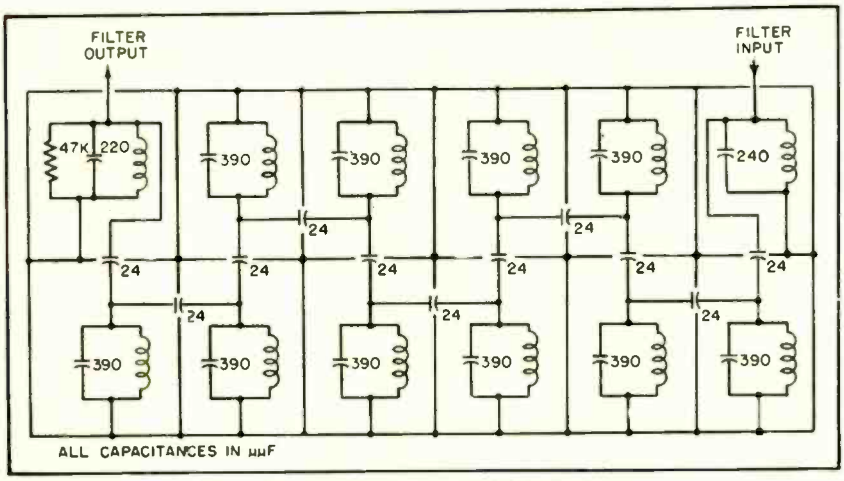

FILTER OUTPUT
FILTER INPUT
47K
220
390
240
24
ALL CAPACITANCES IN μμF

FIG. 4—Lumped i-f filter follows second detector of vhf receiver

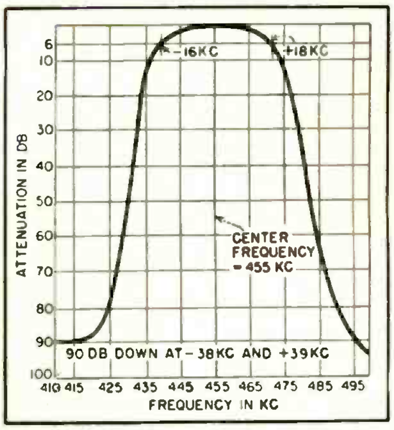


FIG. 5—Selectivity curve of twelve constant-k filter sections

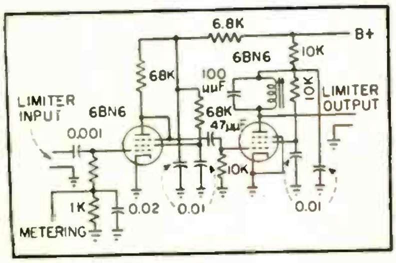

6.8K
B+
6BN6
10K
68K
100 μμF
10K
LIMITER INPUT
6BN6
LIMITER OUTPUT
0.001
68K
47μμF
10K
1K
0.02
0.01
0.01
METERING

FIG. 6—Receiver limiter stages contribute to better reception

across each crystal for vernier frequency adjustment.

This control allows for field adjustment of each transmitter channel to the exact system frequency and of each receiver channel to the exact center of the receiver passband. Frequency stability of ±0.0005 percent from −30 to +60 C ambient temperature ensures maintenance of this frequency adjustment.

The chassis also accommodates the receiver, first local oscillator and the transmitter local oscillator, as well as a complete duplicate receiver r-f head. A multisection wafer switch running two-thirds the length of the chassis performs all channel-change functions including crystal switching.

While the 110-volt a-c power supply is conventional in design, the two vibrator-operated power suppiles designed for 12-volt and 32-volt d-c sources embody a number of interesting features. Heavy-duty interrupter-type vibrators are employed having two tandem sets of interrupting contacts driven by a common reed. To ensure even division of load current between the pairs of contacts, two bifilar wound primaries are provided on the vibrator transformer.

Dry-Disk Rectifiers

High-temperature selenium rectifiers connected in conventional bridge circuits replace the vacuum tube rectifiers in all the high-voltage secondary circuits. The filament strings in both 12-volt and 32-volt d-c models are wired directly across the primary power source with neither side connected to chassis ground, therefore leaving the mains supply floating.

Vibrator life has been good with no vibrator failures in the field. Numerous laboratory tests at 50-percent transmit duty cycle have indicated a life expectancy of several thousand hours. Good efficiency of the vibrator coupled with its satisfactory life expectancy led to the eventual use of the vibrator as a standard item.

Battery drain is of vital importance to owners and operators of small vessels. For this reason a standby-operate switch is provided on the control panel. In the standby position only the receiver and frequency-control-unit tube filaments are heated while in the operate position all heaters are energized. Crystal ovens operate in both positions of the switch.

REFERENCES

(1) "Communication Functions Provided for by the Great Lakes VHF-FM Supplemental Radiotelephone System." Feb. 5, 1954.

(2) Communication from Controller of Telecommunications, Department of Transport, Ottawa, Ontario, Canada.

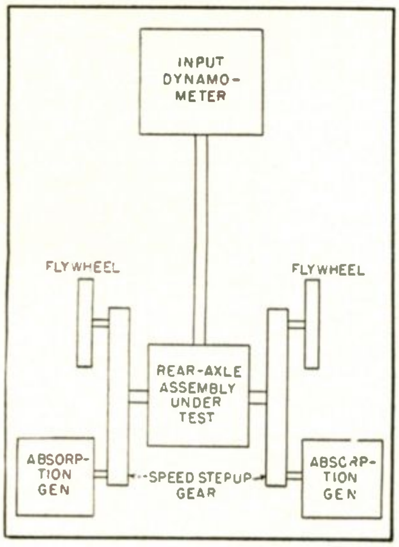
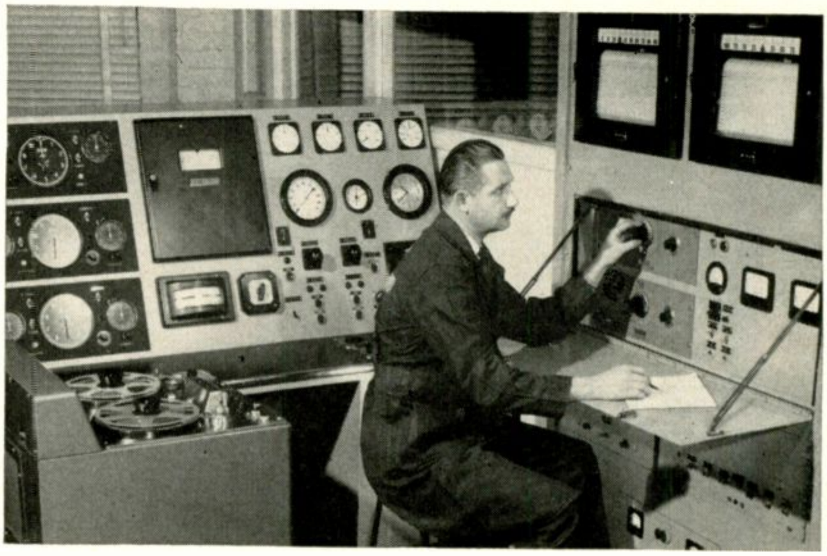


FIG. 1—Arrangement of dynamometers in axle testing setup



Control oscillators at desk are used to set up torque and speed data on f-m tape recorder. Loads corresponding to oscillator signals are shown on chart recorder

Tape Recorder Cycles

Dynamometer control system applies torque and speed loads to truck axle simulating road operation. Frequency-modulated tape carries information for four-hour cycle to control dynamometers through amplidyne system

DYNAMOMETER testing of truck rear axles permits study of axle breakdowns under conditions simulating normal truck operation.

In earlier dynamometer testing systems, cam-actuated switches have been used to add or remove resistance in the dynamometer control circuits to simulate changes in torque and speed. These systems permit only a few steps of control.

To duplicate more closely actual road-test conditions a tape-recorder controlled system has been developed and is now in use at the testing laboratories of the Timken Detroit Axle Division of the Rockwell Spring and Axle Co. Speed and torque data obtained from actual road tests are used to make an f-m tape recording.

In making the recording run, the running speed of the axle is plotted on chart paper against time and the torque values are plotted in a similar manner. These marked charts are placed in chart recorders and allowed to run as normal. The operator follows the recorded lines by varying the frequencies of two oscillators in the tape recorder input. Once recorded, the tape can be used to repeat the four-hour test cycle until axle breakdown occurs.

Dynamometers

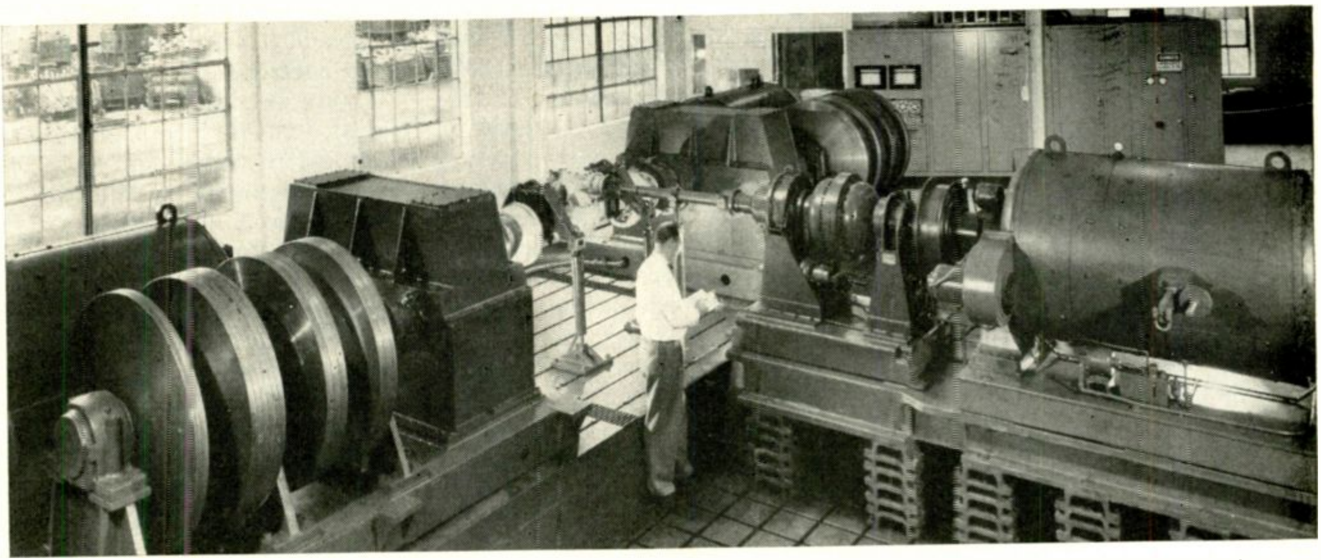
A dynamometer connected to the input of the rear axle assembly acts as the engine and transmission. Two output dynamometers, each connected to an axle shaft, represent loads that may be encountered on the road. Adjustable flywheels, also connected to the axle shafts simulate the inertia of a vehicle. The setup is shown in Fig. 1.

The input and two output dynamometers are direct-current machines capable of motoring or generating as required. Their armatures are connected in series with that of a d-c generator driven by a synchronous motor. Since the dynamometers are connected together both electrically and mechanically in pumpback, the generator only supplies the losses of the system and provides for acceleration and deceleration. Figure 2 shows the electrical arrangement.

Because of the series connection, armature currents in all machines are the same. Therefore, the only control required is for the dynamometer fields so long as armature current is regulated. Armature current is held constant at a preselected value by a regulator acting on the field of the generator.

Each dynamometer is excited by an amplidyne. The amplidyne is used rather than thyratrons because forcing in both directions is necessary. This would require two sets of thyratrons.

Two of the control fields of the amplidyne are connected in buck-boost fashion in the plate circuits of the two output tubes of a preamplifier used to excite the amplidyne. This permits forcing the



Axle-test dynamometer with rear axle assembly in place. Large flywheels on both axle shafts simulate inertia of vehicle under test. One of the tape recorder controls is in background

Truck Axle Tester

By R. P. WASHBURN AND E. B. STAVELY

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General Electric Co.
Schenectady, N. Y.

Applications Engineer
General Electric Co.
Detroit, Mich.

dynamometer fields in both directions. Also on the amplidyne are two other fields, a suicide field to force the voltage of the machine to zero and an anti-hunt field for stabilizing the control system.

The input dynamometer sets the speed of the system. Speed is regulated directly in a closed-cycle system. The voltage of a d-c tachometer generator belted to the shaft of the input dynamometer is compared with a reference voltage set at the desired value. The error signal is fed to the preamplifier to raise or lower the field current of the dynamometer.

Torque on the test axle is controlled by the two output dynamometers. Here, again, an amplidyne is used in conjunction with a preamplifier. However, torque is not regulated directly. Since armature current is held constant by the main generator, field current is a measure of torque.

In this case the voltage across a resistor in series with the dynamometer field is a measure of field current and is compared with a reference voltage to obtain an error signal.

The cycling control furnishes two varying reference signals to the amplidyne preamplifiers, one to control the input dynamometer speed and the other to control the total torque being transmitted by the axle assembly under test.

Recording Medium

The first item considered in the design of the cycling control was the recording medium. Several requirements were placed on the equipment that made standard techniques and equipment not directly applicable. The time of one cycle was to be four hours and the run was to be repeated without interruption an indefinite number of times until the axle showed signs of failure. The ability of the cycling control to repeat the initial program was not stated but it was felt an error of ±5 percent of the maximum value should be adequate. The type of conditions encountered during a run and the frequency of a change in condition during a run would be variable and would be made the worst possible to test the axle thoroughly. These requirements practically eliminated all but magnetic tape as a recording medium.

Amplitude recording was found the most common system in use. The variables encountered that would tend to cause drift or errors during playback with amplitude recording are tape nonuniformity, playback-head wear, tube aging, speed irregularities and magnetization of the tape head. A rough figure of repeatability for such a system is 20 percent, which is considerably above the limit set for the test equipment. In the best magnetic tapes available, amplitude-variations reproduced are guaran-

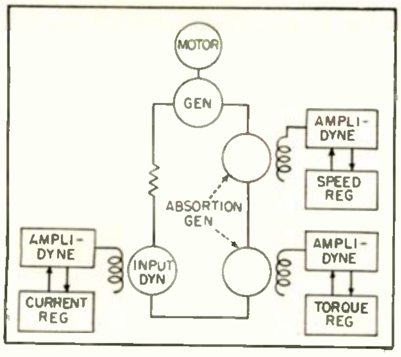


FIG. 2—Closed-loop dynamometer system showing amplidyne controls

teed only to plus or minus one-half decibel, or about six percent.

To avoid the defects of amplitude recording, the frequency-modulation method was chosen. The simplest system, and the one used in the cycling control, consists of a laboratory-type audio oscillator, tape recorder and a discriminator.

A frequency-recorded test program is made by turning the main dial of an audio oscillator and recording the excursions of frequency about a selected value. Upon playback this signal is applied to a discriminator to produce a d-c signal proportional to the extent of the frequency excursion.

The discriminator output voltage is unaffected by tape amplitude variations. The output is affected, however, by changes in tape speed. In a good commercial recorder all these speed variations are very small. Thus, the reproduction error on such equipment is much smaller than the amplitude method and repetition of signals over long playback periods is a measure of discriminator drift rather than recording errors. A total error for such a system should be on the order of one percent of the maximum signal.

The complete cycling control consists of the tape recorder and two variable audio oscillators, one fixed oscillator, two strip chart recorders, a discriminator chassis and one power supply mounted in a standard control cabinet. The electrical arrangement of the units is shown in Fig. 3. The oscillators are used only to make a recording for a test run and the reversal oscillator is used only at reversal points. The four summing resistors supply a half-volt signal to the recorder.

The magnetic-tape recorder is a modification of an Ampex 300 broadcast and transcription recorder. The modifications consisted of a reversing unit to detect reversal signals, a mechanism to change tape direction and relays for selection of recording and playback heads.

To avoid the possibility of a sudden jar to the axle during the tape reversal on playback, the signals at the ends of the tape are returned to a steady condition of minimum torque and speed before reversal. A relay in the discriminator holds the output constant during the time of reversal when the output of the recorder goes to zero.

The main playback amplifier can be energized from the record preamplifier or from either of the two playback pickup heads. During recording the latter arrangement is advantageous since the amplidyne signal is derived directly from the tape as it is in repeated playback. This assures that the record is really on the tape and that repeated playback will be exactly the same as during the recorded run.

The output of the playback amplifier is fed to a high-fidelity audio amplifier to produce a low source impedance with sufficient power for driving the discriminators.

Discriminators

The discriminator unit consists of two similar circuits and one common bias supply. The circuit controlling dynamometer speed will be considered first. The function of this circuit is to receive variable frequency signals in the 3,000 to 6,000 cycle range and convert them into a d-c voltage ranging from zero to −105 volts. The range and polarity was required to match the range and polarity of the amplidyne speed control.

Figure 4 shows the discriminator circuit. Tubes V_1 through V_5 form the speed control circuit. The discriminator input is filtered for signals above 2,500 cycles by a high-pass filter. Resistor R_1 and potentiometer R_2 form the impedance matching terminations for proper filter operation and a gain adjustment. The sine-wave signal is then doubly amplified and clipped into square-wave pulses by tube V_1. Its output is coupled to V_2 which is a conventional bistable multivibrator. The output is a square wave which is differentiated by C_1 and R_4. Resistor R_4 is returned to B+ instead of ground.

Only the negative pulses of the differentiated wave will be passed by tube V_{4A}. This starts the plate of V_{3A} downward and starts to cut off conduction of V_{3B}. This causes the cathode current to decrease, lowering the bias on V_{3A} and causing that half to increase in conduction, further decreasing its plate voltage. The coupling action of C_2 makes this change drive itself to completion and gives a steep positive pulse output. This leaves V_{3A} fully conducting and V_{3B} cut off.

Upon termination of the above change and its starting pulse, the grid of V_{3B} starts increasing its potential through the 2-megohm resistor returned to B+. Capacitor C_2 is also charged through this resistor. These determine the time constant for the off time of tube V_{3B}.

When the potential of the grid reaches cutoff for the particular cathode voltage, V_{3B} starts conducting. This increases cathode cur-

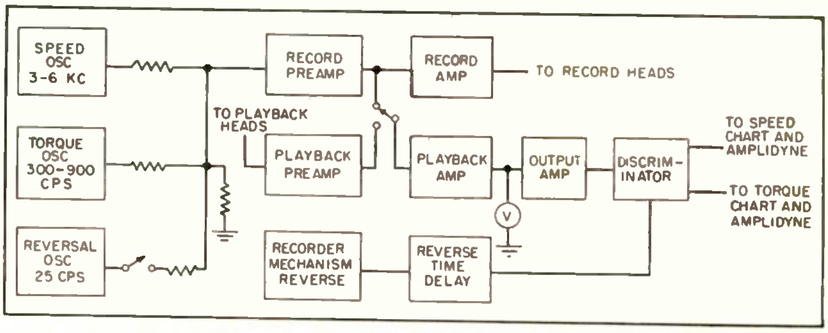


FIG. 3—Manually controlled oscillators supply speed and torque information to tape recorder. Discriminator separates signals on playback to control dynamometer

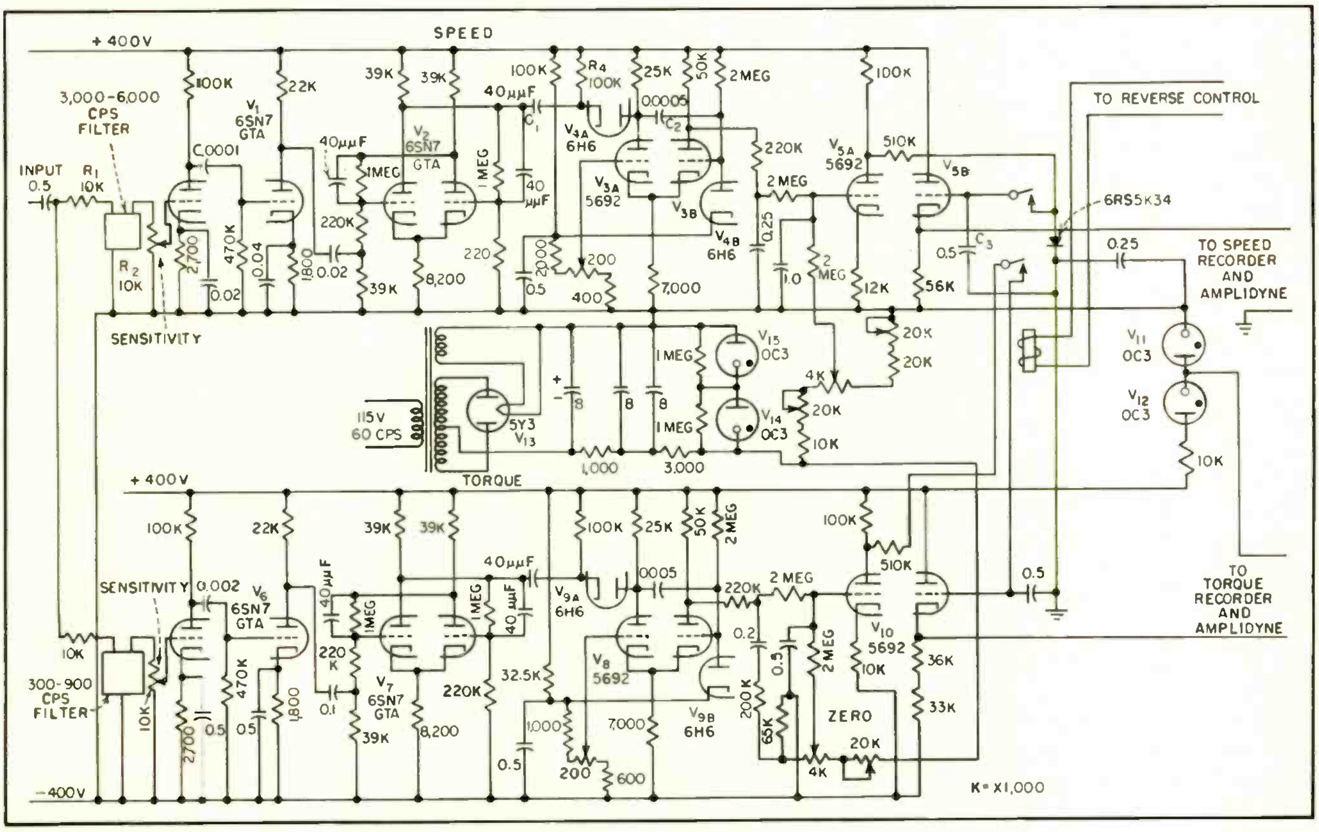

SPEED
+400V
3,000-6,000 CPS FILTER
INPUT 0.5
R1 10K
R2 10K
SENSITIVITY
V1 6SN7 GTA
V2 6SN7 GTA
V3A 6H6
V3A 5692
V3B
V4B 6H6
V5A 5692
V5B
C1
C2
C3
R4 100K
6RS5K34
TO REVERSE CONTROL
TO SPEED RECORDER AND AMPLIDYNE
V11 OC3
V12 OC3
V13 5Y3
V14 OC3
V15 OC3
115 V 60 CPS
TORQUE
+400V
SENSITIVITY
300-900 CPS FILTER
V6 6SN7 GTA
V7 6SN7 GTA
V8 5692
V9A 6H6
V9B 6H6
V10 5692
ZERO
TO TORQUE RECORDER AND AMPLIDYNE
-400V
K = X1,000

FIG. 4—Discriminator uses two similar circuits with bandpass filters to separate low-frequency torque information from speed information recorded at a higher frequency

rent and starts cutting off V_{3A}.

Another suicide action occurs whereby the grid of V_{3B} is driven more positive and the previous steady-state condition has been resumed. The voltage excursion is limited by the action of V_{4B}. This limits the upper voltage of the grid of V_{3B} and thus the lowest plate voltage or output voltage.

The output pulse width is determined by the potential of the grid of V_{3A} and is controlled by a potentiometer. This control sets the cathode potential of V_{3A} and determines the critical grid voltage.

Thus, each time a full sine wave is passed by the filter unit, there is an output pulse. The output pulses of constant width and amplitude are averaged and amplified by V_{5A}. This d-c voltage is thus proportional to frequency. A separate negative power supply increases stage gain and provides a zero control.

The output of the speed-control section must be a negative voltage to ground, and full speed corresponds to −105 volts to match the manual control. Thus, the output should be of low impedance, and be capable of negative to ground operation. This was accomplished by placing the B− of the power supply −210-volts negative to ground by means of two glow tubes. Thus B+ is +190 when the power supply is adjusted to 400 volts. The d-c amplifier, V_{5A}, is directly coupled to the cathode-follower output, V_{5B}, through a relay.

Reversal

The relay operates from the reverser unit and disconnects the cathode-follower grid from the amplifier tube upon tape reversal. The grid voltage is held constant by capacitor C_3 until the relay picks up ten seconds after tape reversal and full control signals.

Since the signal levels are held constant just before and after reversals, there is no switching surge to jar the dynamometer equipment. A small, high-voltage, selenium rectifier is connected from the cathode-follower grid to ground to prevent positive excursions of this grid relative to ground, which would cause a speed reversal.

In the torque channel the torque signal is treated identically with the speed signal. Here the frequency range is greater, 300 to 900 cycles, than the 2-to-1 speed ratio since output voltage must be twice the range, −105 to +105 volts relative to ground. The additional gain is obtained in the d-c amplifier. No rectifier is used since positive voltage to ground is required.

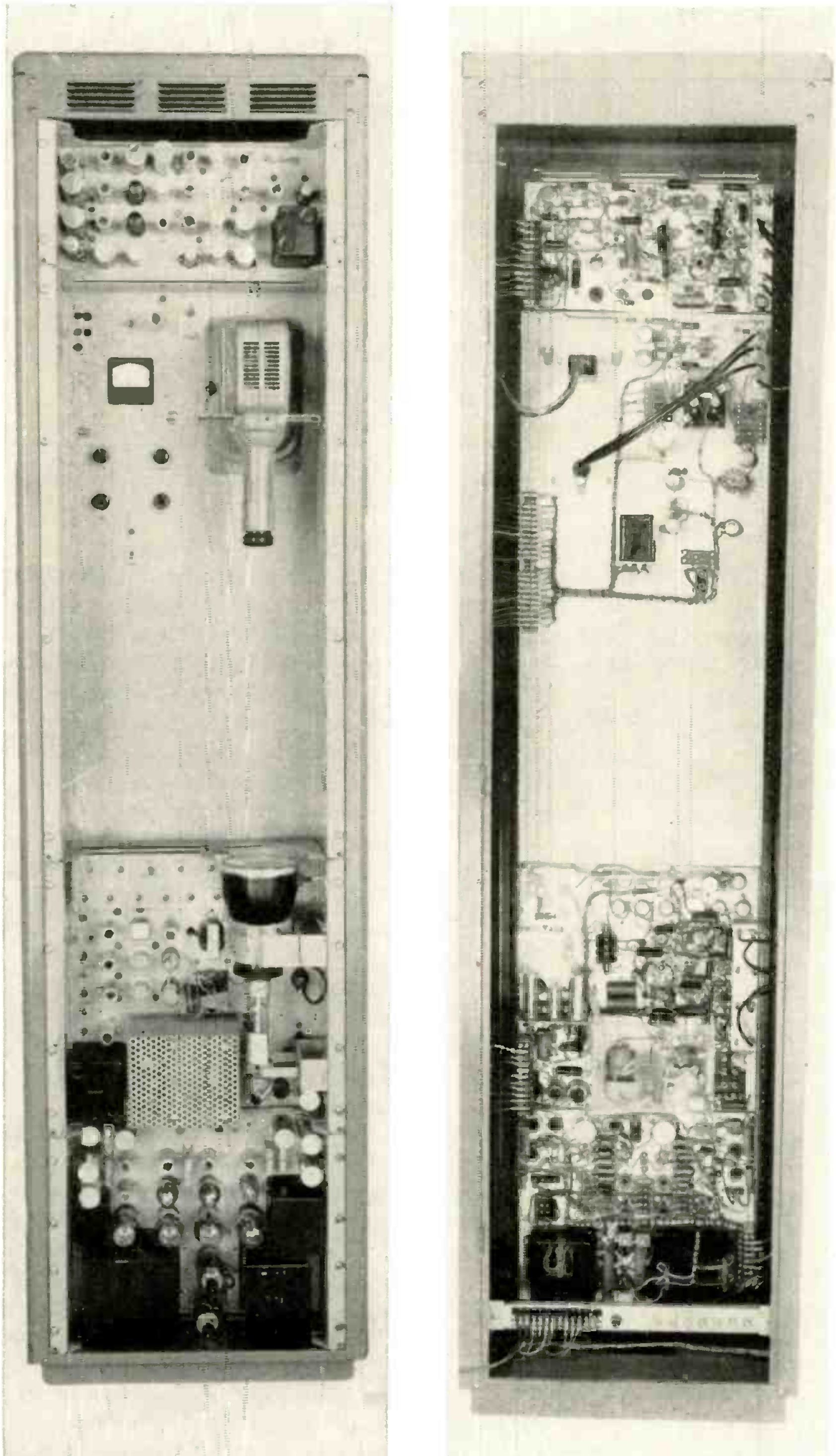
The output of the playback amplifier is connected to a twin-T network set to reject all frequencies outside the 24 to 26-cycle region. Upon receipt of a 25-cycle tone, the signal is passed on and fires a small thyratron tube that actuates a plate relay causing reversal of the capstan motor and the selection of the opposite pair of recording and playback heads.

An additional time-delay unit has been added to the control to prolong the few seconds delay already built in the reverser. This was necessary to allow a longer time for the discriminator to establish the steady value existing prior to reversal.

The over-all accuracy of reproduction of the recorded values is on the order of one percent of full-scale values. Drift in the power supply and discriminator seems to account for most of the error.

Television Flying-Spot

Picture source has resolving power in excess of 600 lines with a signal-to-noise ratio of 35 db or more. Operation may be changed from positive to negative slides by means of a switch in the clamp circuit. Gamma correction compensates for crt nonlinearity



Front and rear views of flying-spot scanner employing 5-inch projection crt

FUNDAMENTAL need in a tv broadcasting station is for a simple, low-cost source of picture signal for test pattern, station identification and general station maintenance. The television development laboratory and receiver factory also need a source of high-quality picture signal. Ability to vary the picture content, such as by use of different slides, is very important.

Study has shown that the opaque scanner has an advantage over the slide scanner in that sometimes the material is easier to prepare. On the other hand, the slide scanner has many advantages. There is no problem keeping glass-mounted slides clean, easily stored and in ready-reference file. The slide scanner requires only one phototube instead of at least two for the opaque scanner.

The slide scanner has two to three times the efficiency of the opaque scanner and as a result the cathode-ray tube voltage in the opaque scanner must be two to three times the 20 kilovolts required in the slide scanner. The optics can be of high quality without incurring the expense required in the opaque scanner.

The flying-spot scanner, although somewhat more expensive than the monoscope, compensates for this by its ability to provide a variety of picture signals limited only by the number of different slides available. The monoscope invariably is a single-signal source.

Operation

In the block diagram of Fig. 1, the cathode-ray-tube beam operating at 20 to 25 kilovolts scans a rectangular raster determined by the horizontal and vertical scanning currents derived from the deflection and high-voltage unit.

Slide Scanner

By **A. J. BARACKET**
Federal Telecommunication Laboratories
Nutley, New Jersey

Negative blanking pulses applied to the crt grid cut off the beam during horizontal and vertical retrace times.

The flying spot of light is focused by means of the objective lens onto the test pattern or other film slide. The spot of light, modulated by the content of the film, is collected through a condensing lens into a multiplier phototube. The photocathode current, of the order of 0.1 microamperes in the highlights, is amplified to 100 microamperes at the multiplier-phototube anode. The signal voltage at the anode load is then amplified by normal video-amplifier techniques. In the process gamma correction is applied to compensate for the monitor or tv receiver picture-tube black compression.

Phosphor Persistence

The projection flying-spot cathode-ray tube phosphor has an extremely short persistence amounting to 1.4 microseconds for a 50-percent response. As short as this persistence is, it must be compensated for

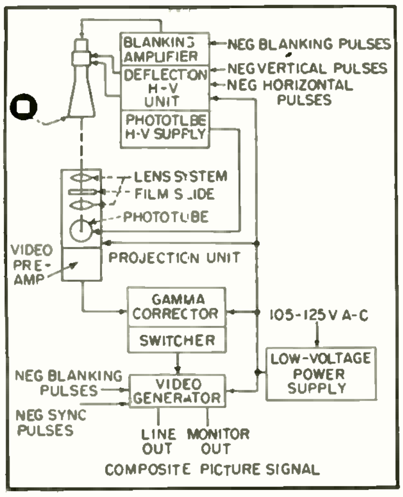

BLANKING AMPLIFIER
NEG BLANKING PULSES
DEFLECTION H-V UNIT
NEG VERTICAL PULSES
NEG HORIZONTAL PULSES
PHOTOTUBE H-V SUPPLY
LENS SYSTEM
FILM SLIDE
PHOTOTUBE
VIDEO PRE-AMP
PROJECTION UNIT
GAMMA CORRECTOR
SWITCHER
105-125 V A-C
LOW-VOLTAGE POWER SUPPLY
NEG BLANKING PULSES
NEG SYNC PULSES
VIDEO GENERATOR
LINE OUT
MONITOR OUT
COMPOSITE PICTURE SIGNAL

FIG. 1—Flying-spot scanner crt beam operates at 20 to 25 kilovolts

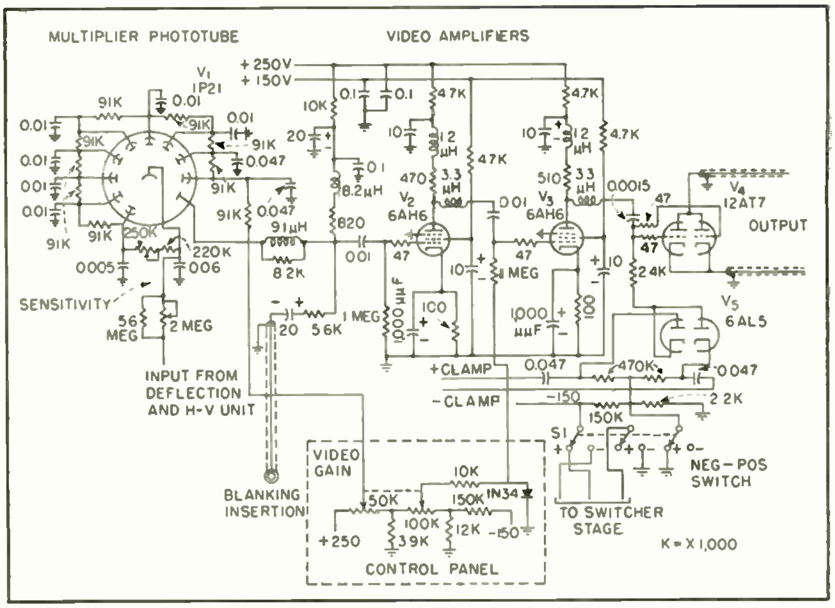

MULTIPLIER PHOTOTUBE
VIDEO AMPLIFIERS
V1 1P21
+250V
+150V
91K
0.01
0.047
250K
220K
0.005
.006
SENSITIVITY
56 MEG
2 MEG
INPUT FROM DEFLECTION AND H-V UNIT
10K
20
8.2μH
820
91μH
8.2K
.001
47
1 MEG
20
5.6K
1000 μμF
100
V2 6AH6
470
3.3 μH
12 μH
4.7K
0.1
10
V3 6AH6
510
47K
0.0015
V4 12AT7
OUTPUT
2.4K
V5 6AL5
+CLAMP
-CLAMP
0.047
470K
2.2K
-150
150K
S1
NEG-POS SWITCH
TO SWITCHER STAGE
BLANKING INSERTION
VIDEO GAIN
50K
100K
3.9K
12K
1N34
+250
CONTROL PANEL
K = X 1,000

FIG. 2—Projection unit of monochrome scanner uses video amplifiers having a response of less than 3 db down at 12 mc. Black level is set by clamp, V_5, prior to gamma correction in the control panel circuits

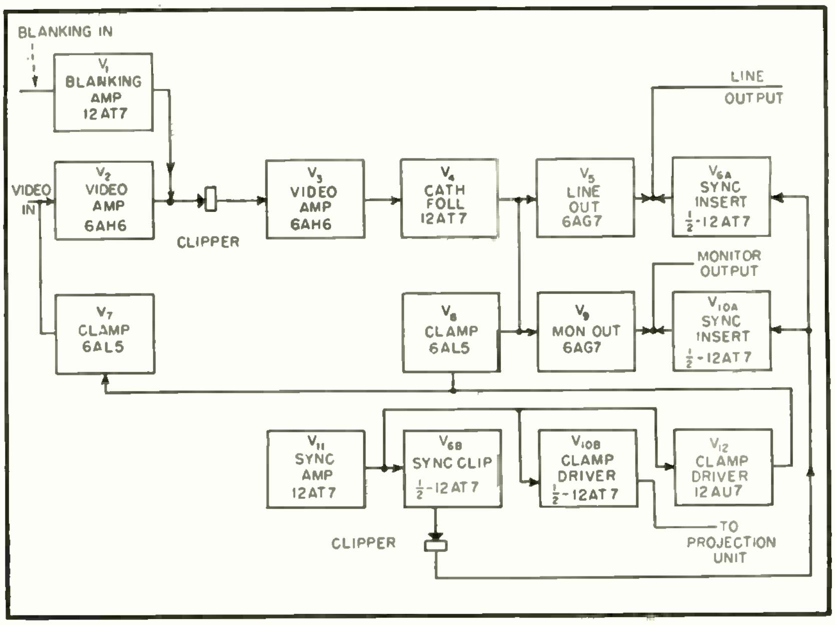

BLANKING IN
V1 BLANKING AMP 12AT7
VIDEO IN
V2 VIDEO AMP 6AH6
CLIPPER
V3 VIDEO AMP 6AH6
V4 CATH FOLL 12AT7
V5 LINE OUT 6AG7
V6A SYNC INSERT ½-12AT7
LINE OUTPUT
MONITOR OUTPUT
V7 CLAMP 6AL5
V8 CLAMP 6AL5
V9 MON OUT 6AG7
V10A SYNC INSERT ½-12AT7
V11 SYNC AMP 12AT7
V6B SYNC CLIP ½-12AT7
V10B CLAMP DRIVER ½-12AT7
V12 CLAMP DRIVER 12AU7
TO PROJECTION UNIT
CLIPPER

FIG. 3—Video generator uses sync insertion at output to make room for video. Control panel video output is fed into and amplified by 6AH6 tubes V_2 and V_3. Tube V_1 amplifies blanking signal to proper level for insertion into plate circuit of V_2

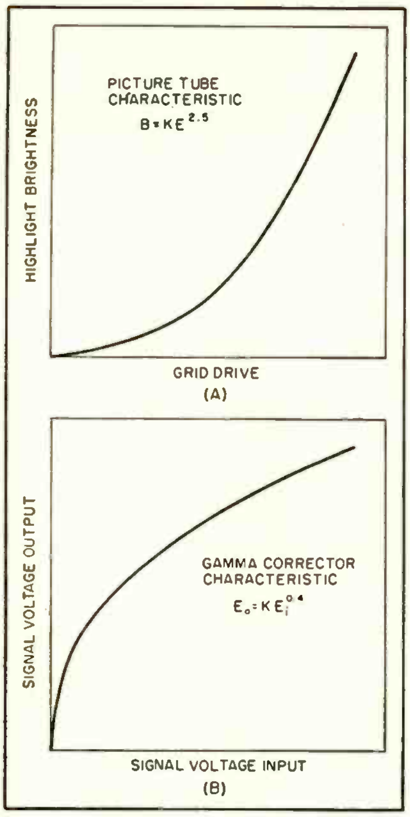


FIG. 4—Nonlinearity of picture tube characteristic (A) and compensated curve obtained by using germanium diode in control-panel circuit (B)

to prevent excessive picture streaking. The compensation consists of a high-pass filter network effectively the inverse of the low-pass filter representing the phosphor decay.

To provide maximum convenience and accessibility in this equipment, the scanner is cabinet mounted. Other scanners intended more for program operation than for maintenance and test-pattern signal are console mounted.

Video Amplification

The overall amplitude-frequency characteristic of the video amplifier yields a response of less than 3 db down at 12 mc. The fall-off is purposely made slow to give a good phase characteristic and transient repsonse.

Figure 2 shows the simplified schematic of the projection unit. Tube V_1 is the 1P21 multiplier phototube selected for its inherent low-noise and high-sensitivity characteristics. Tubes V_2 and V_3 are wideband video amplifiers ahead of the clamped output stage. The clamp V_5 sets black level prior to gamma correction in the control panel circuits.

The video output of the control panel is amplified by V_2 and V_3 in the video generator, Fig. 3. A clamp at V_2 grid sets black level for blanking insertion, in the plate circuit of V_2. A cathode follower V_4 drives the grids of the line-out and monitor-out stages V_5 and V_9. Tube V_1 amplifies the blanking signal to a level where it can be inserted in the plate circuit of V_2 and clipped by the crystal diode.

The grids of both the line output and monitor output tubes are clamped to limit the operating range on the grid base of these tubes. To further provide room for the video, sync is inserted in the output stages, V_{6A} and V_{10A}. Tubes V_{11} and V_{6B} are sync-amplifier stages and V_{12} is a clamp-pulse amplifier and driver.

Gamma Correction

The light-input versus signal-current output of the 1P21 phototube is linear over the range used. The amplifiers have a good amplitude-linearity characteristic. The cathode-ray tube in a picture monitor or television receiver, however, has a nonlinear characteristic of highlight brightness versus grid drive as shown in Fig. 4A. Therefore, if a signal from a linear device such as a flying-spot scanner were to be displayed without any compensation, the picture would be contrasty with very few tone separations in the dark gray region. This is due to the extreme curvature of the picture-tube characteristic near black level.

Figure 4B shows the compensation required to overcome the picture tube nonlinearity. Use is made of the nonlinearity of a germanium diode in the control-panel circuit of Fig. 5A to expand the blacks and dark grays according to the curve of Fig. 4B. This yields a gamma of 0.4 in the scanner to compensate for the picture-tube gamma of 2.5.

Phosphor Lag Compensation

The resolution deterioration due to phosphor decay is equivalent to that caused by a low-pass filter. For compensation, a high-pass filter is needed. This is obtained by use of

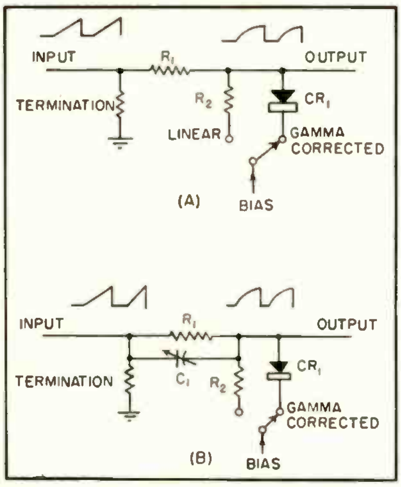

INPUT
OUTPUT
R_1
TERMINATION
R_2
CR_1
LINEAR
GAMMA CORRECTED
(A)
BIAS
INPUT
OUTPUT
R_1
TERMINATION
C_1
R_2
CR_1
GAMMA CORRECTED
(B)
BIAS

FIG. 5—Gamma correction circuit (A) and gamma corrector and phosphor lag compensator (B)

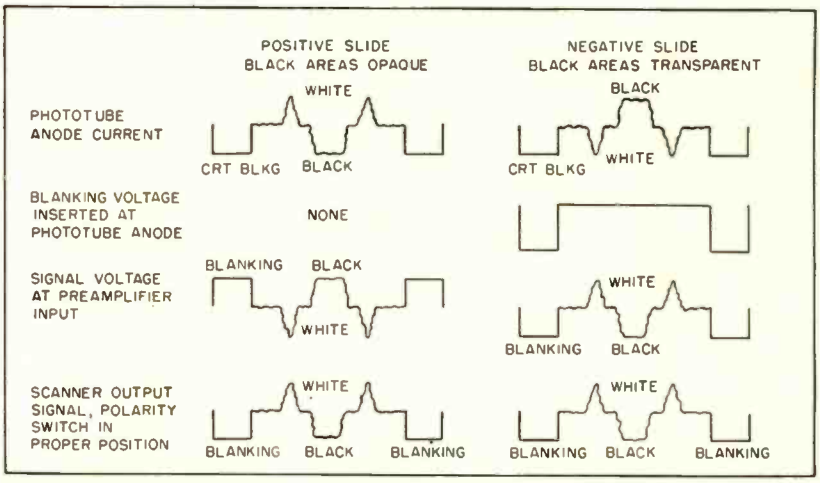
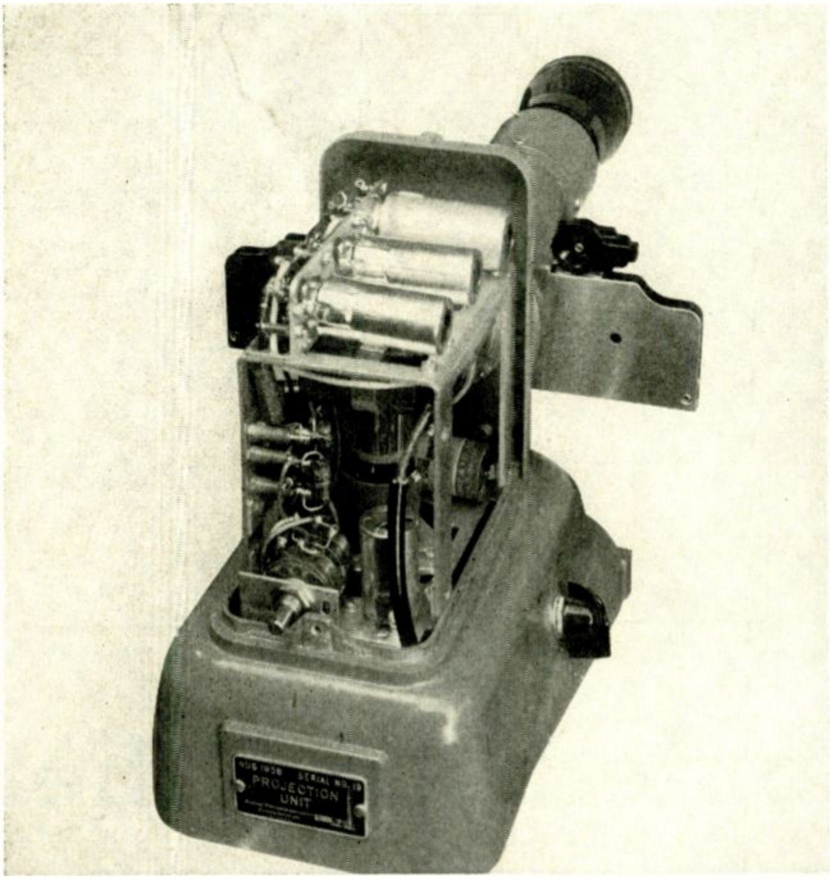

POSITIVE SLIDE
BLACK AREAS OPAQUE
NEGATIVE SLIDE
BLACK AREAS TRANSPARENT
PHOTOTUBE ANODE CURRENT
WHITE
CRT BLKG
BLACK
BLACK
CRT BLKG
WHITE
BLANKING VOLTAGE INSERTED AT PHOTOTUBE ANODE
NONE
SIGNAL VOLTAGE AT PREAMPLIFIER INPUT
BLANKING
BLACK
WHITE
WHITE
BLANKING
BLACK
SCANNER OUTPUT SIGNAL, POLARITY SWITCH IN PROPER POSITION
WHITE
BLANKING
BLACK
BLANKING
WHITE
BLANKING
BLACK
BLANKING

FIG. 6—Blanking inserted for negative slide operation before and after compensation. Scanner circuits automatically compensate for departure of blanking from black level


AUG 1950 SERIAL NO. 10
PROJECTION
UNIT

Inner view of projection unit showing video preamplifiers. Unit contains 1P21 multiplier phototube having a photocathode current of the order of 0.1 microamperes in the highlights

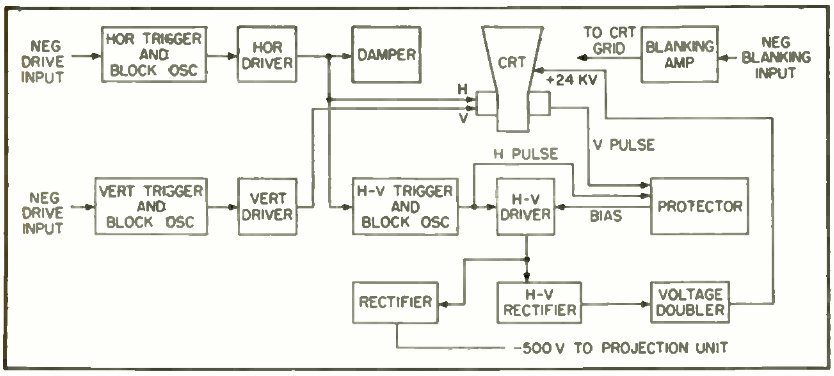

NEG DRIVE INPUT
HOR TRIGGER AND BLOCK OSC
HOR DRIVER
DAMPER
CRT
TO CRT GRID
BLANKING AMP
NEG BLANKING INPUT
+24 KV
H
V
H PULSE
V PULSE
NEG DRIVE INPUT
VERT TRIGGER AND BLOCK OSC
VERT DRIVER
H-V TRIGGER AND BLOCK OSC
H-V DRIVER
BIAS
PROTECTOR
RECTIFIER
H-V RECTIFIER
VOLTAGE DOUBLER
-500 V TO PROJECTION UNIT

FIG. 7—Deflection and high-voltage unit uses output of a 1B3 rectifier to supply 24 kv to cathode-ray tube

an RCR compensator circuit consisting of C_1, R_1 and either R_2 or diode CR_1 in Fig. 5B.

In this circuit, the individual losses normally caused by gamma correction and phosphor lag compensation are avoided, resulting in only one loss.

Signal-to-Noise Ratio

The source of noise in flying-spot scanners is primarily shot noise in the photocathode signal current. Techniques have been described for optimizing the signal-to-noise ratio.[1] These have been used with good success.

Positive and Negative Slides

Many of the station identification and commercial slides are positive slides. However, a very convenient source of programming material is the readily available 35-mm double frame negative. Use of negatives is provided for in this scanner by means of a switch in the clamp circuit. This feature is made convenient by use of circuits that automatically compensate for the departure of blanking from black level in a negative slide. Figure 6 shows the scanner signal from a negative slide before and after compensation.

Beam Voltage Effect

The greater the light output of the projection crt the better is the signal-to-noise ratio. Resolution is also favorably affected by an increase in high voltage due to the resultant smaller spot size. With the high efficiency of the transparent-slide scanner it is not necessary to go beyond 20 to 25 kilovolts for 600-line resolution and 35-db signal-to-noise ratio. At 20 to 25 kilovolts d-c operation in the scanner, the x-ray radiation is negligible and was measured to be far below minimum average dosage. At much higher beam voltages there is a more difficult situation with respect to high-voltage insulation and the prevention of corona and breakdown.

In the scanner, high voltage is obtained independently in a pulse circuit located in the deflection unit as shown in the block diagram of Fig. 7.

The flying-spot scanner for 2 by 2-in. slides has the following characteristics: beyond 600-line resolution; over 20-to-1 contrast ratio; signal-to-noise ratio beyond 35 db; gamma correction to compensate for the monitor or receiver cathode-ray tube; ability to handle both positive and negative slides; adequate phosphor-lag compensation; convenient rack cabinet mounting; excellent stability, partially due to regulated high and low-voltage supplies.

Achnowledgment is due to work of T. M. Maxwell, Jr., and S. DeMars on circuits and E. Galuska and F. Numrich for chassis arrangements.

REFERENCE

(1) A. J. Baraeket, Signal-to-Noise Ratio in Flying-Spot Scanners, *Tele-Tech* Dec. 1951.

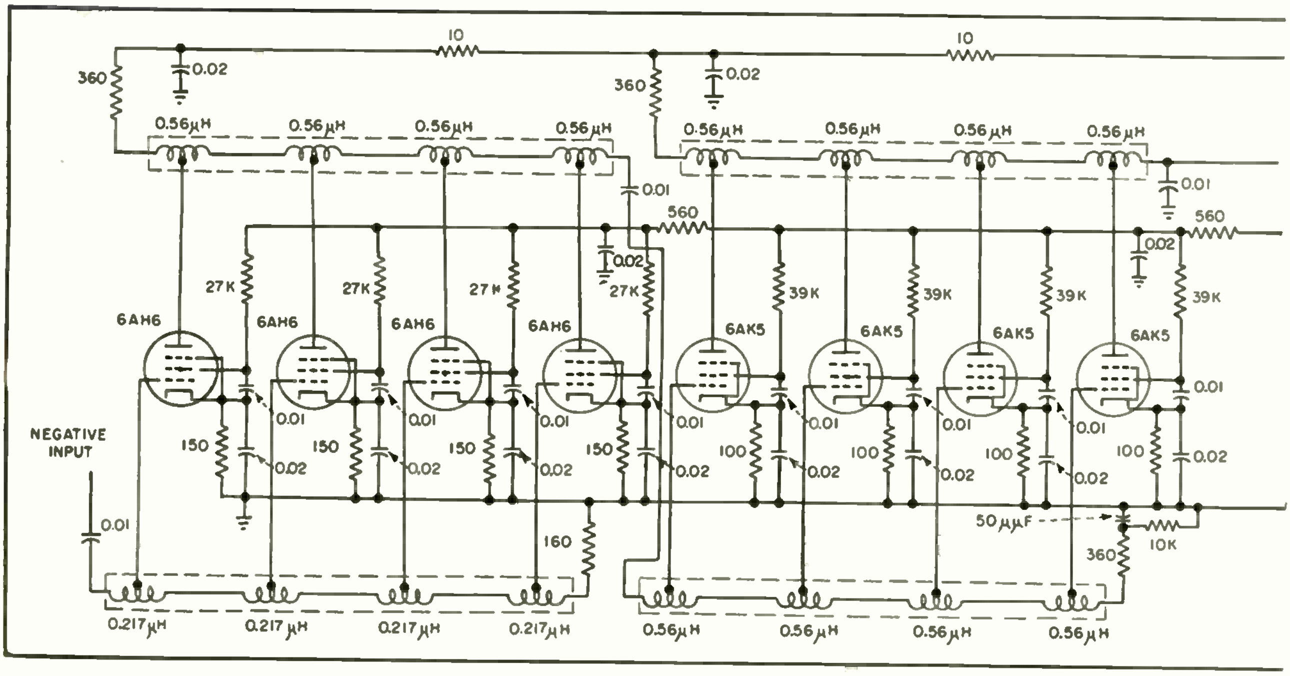

10
10
360
0.02
360
0.02
0.56μH
0.56μH
0.56μH
0.56μH
0.56μH
0.56μH
0.56μH
0.56μH
0.01
0.01
560
560
0.02
0.02
27K
27K
27K
27K
39K
39K
39K
39K
6AH6
6AH6
6AH6
6AH6
6AK5
6AK5
6AK5
6AK5
NEGATIVE INPUT
0.01
150
150
150
150
100
100
100
100
0.01
0.02
0.02
50μμF
10K
360
160
0.217μH
0.217μH
0.217μH
0.217μH
0.56μH
0.56μH
0.56μH
0.56μH

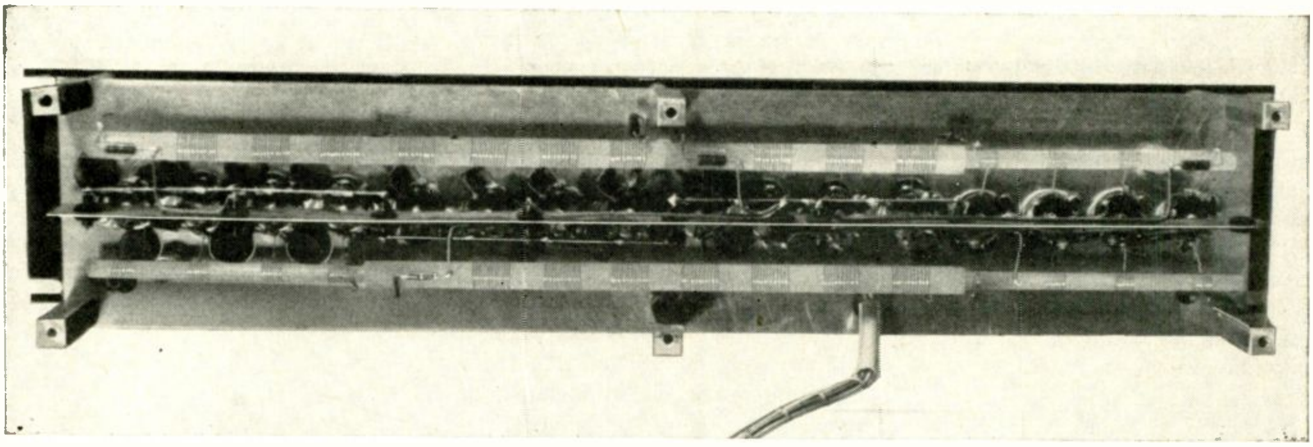
FIG. 1—Schematic of distributed amplifier. Delay-line coils are wound on threaded polystyrene rods with No. 28 wire: 0.56-μh coils have

Distributed Amplifier

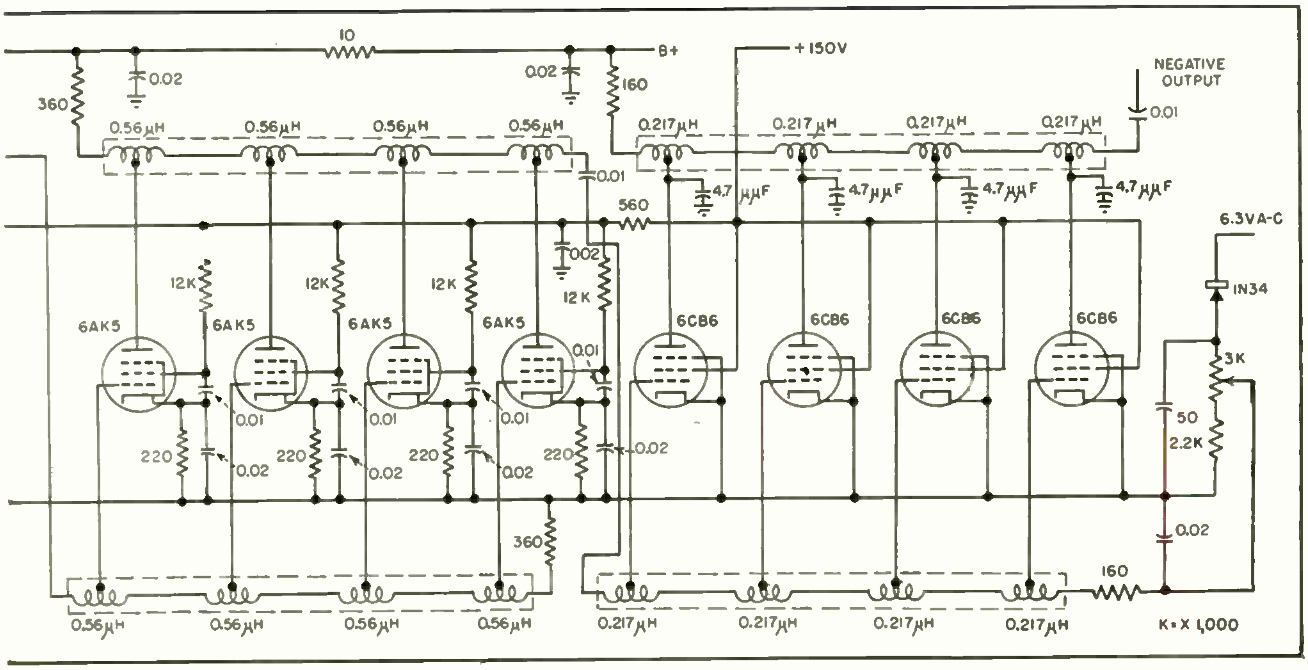
Wide-band amplifier uses traveling-wave principle to obtain gain of 50 to 60 db over a range of 5 to 100 mc. Pulses with rise times as short as 4.2×10^{-9} second are faithfully reproduced. Unit has up to 8-volt output with good linearity.

SCINTILLATION counters, which are used in nuclear-physics research for detection and energy measurement of particles, usually do not have sufficient output to operate scalers and coincidence circuits directly and require an intermediate stage of amplification. Due to the short rise time of the signal and the high attenuation imposed by the associated cabling, a high-gain, wide-band amplifier is necessary.

In many laboratories, the distance between the scintillation counters proper and the amplifiers, and between the amplifiers and the coincidence and scaling circuits is considerable. In the present application, this distance is approximately 350 feet. To transmit pulses of 5 ×



Bottom view of amplifier showing delay lines. Shield between the output and input lines serves as a ground plane to which bypass capacitors, cathode resistors etc are grounded.



13 turns on 3/8-in. o.c. rod with 24 thd per in.; 0.217-μh coils have 9 turns on 1/4-in. o.d. rod with 32 thd per in.

for Nuclear Research

By KURT ENSLEIN

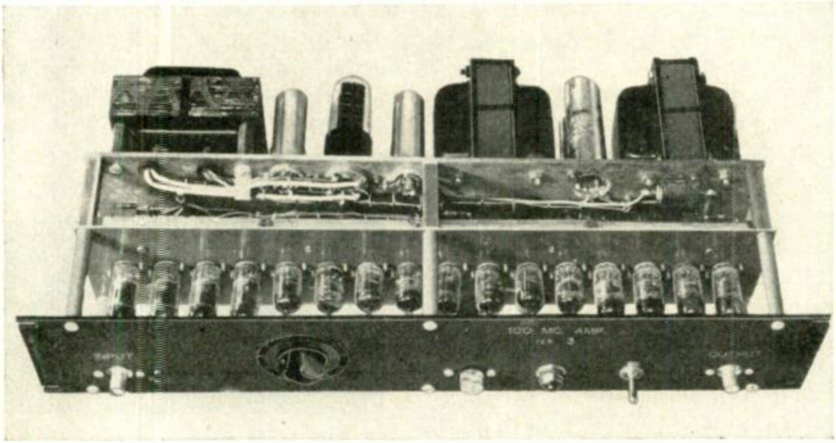
University of Rochester
Rochester, N. Y.

10^{-9} sec rise time over such distances, one of the few practical methods is to use properly terminated coaxial cables. From the standpoint of obtaining signals of fairly large amplitude with a minimum of tube current, it is desirable to use cable with the highest possible characteristic impedance while simultaneously satisfying the attenuation criteria.

Though cables of large diameter are available with 250 ohms impedance, this installation uses 160-ohm cable for short runs and RG/62-U cable of 100 ohms characteristic impedance for long runs. Even the 100-ohm cable has substantial attenuation for runs of this length. Therefore, it is not uncommon to have all the computing circuits close together, with only slow information being transmitted over long cables.

Since 160 ohms is the highest practical cable impedance for our purposes, a distributed amplifier with input and output impedances of 160 ohms was designed to work between two such cables. Since the signal from the counter multiplier phototube anode is a negative pulse and coincidence circuits and scalers often work on negative inputs, the amplifier must be noninverting. This dictates an even number of stages, if grounded cathode circuits are used.

Finally, the questions of gain



Amplifier with cover removed. Unit's power supply is mounted at rear. Tubes are free of obstructions permitting ample air circulation and maximum output amplitude remain. The output from scintillation counter multiplier phototubes varies over wide ranges. In this case, however, the quantity of interest is the minimum amplitude for the speed of response indicated earlier. A good value for this is 0.05 to 0.1 volt peak. Coincidence circuits usually require inputs in the order of 3 to 5 volts. This fixes the value of gain between 50 and 60 for the amplifier. The maximum output signal should not be less than about 5 volts peak.

The bandwidth criteria were derived from the rise time and maximum duration of pulses that are expected to be passed by this amplifier.

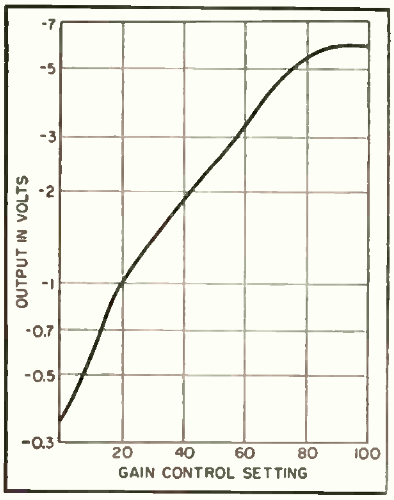


FIG. 2—Amplifier output voltage against gain-control setting for —0.1-v, 0.06-μsec input pulse

Design Data

The schematic of the amplifier is shown in Fig. 1. Design principles for distributed amplifiers have been developed in the literature.[1,2] It has been shown that minimum number of tubes is achieved for a given gain and a given bandwidth when the gain per stage is 2.72. This criterion is completely valid only when each stage consists of the same tube type, the tubes are operated at their maximum gain-bandwidth product and the gain per stage is equal for all stages. Measurements have shown that since the overall bandwidth of the amplifier is only 100 mc, no serious difficulty will be encountered from input impedance and cathode resonance problems for the tubes used.

The amplifier was designed so that the average gain per stage would be approximately 2.72. From the design objectives, the number of stages in this amplifier must be even. For two stages, gain = $2.72^2 = 7.4$, which is too low. Four stages give $2.72^4 = 54.9$, which is a practical number for this purpose.

The original design was based on the use of constant-K lines. It was found, however, that these lines were unduly susceptible to stray effects such as changes in tubes and slight errors in inductances. Since it was desired to keep the number of adjustments to an absolute minimum, a design based upon M-derived lines was developed. While these lines are considerably more difficult to construct initially, experience has shown that distributed amplifiers constructed with them are tolerant of large changes in L and C.

It was found in the amplifier under discussion, that no change in rise time or reflections could be observed if an entirely different set of tubes was inserted. As constructed, the amplifiers have no alignment adjustments and none of the ten built to date have exhibited any real departure from the characteristics shown.

Only two types of artificial transmission lines have been used, 160 ohms and 360 ohms. While a greater gain-bandwidth product could have been obtained by using a greater variety of lines, the additional design time was not felt justified, since the amplifier exceeds the specifications as it is.

Impedance Matching

No great care has been taken in the amplifier to match capacitances exactly.

For example, the output capacitance of the 6AH6 is 2 μμf and the input capacitance of the 6AK5 is 4μμf. Yet both the plate line of the first stage and the grid line of the second stage are of the same characteristic impedance. One or the other, or both, of the lines must be mismatched. Yet, from the practical standpoint, the effect is negligible as long as the velocity of propagation in respective grid and plate lines is identical and one of the lines is properly terminated.

Suppose the plate line of the first stage is of characteristic impedance 360 ohms and therefore properly terminated. No adverse effects occur until the first section of the grid line of the second stage is encountered. A reflection is produced at this point. This reflection travels down the plate line of the first stage. Since this line is properly terminated, the signal is absorbed by the termination. The same thing happens on the second and other grids. Here, however, a difficulty is encountered. Suppose a reflection is created at the fourth grid of the second stage. This reflection will travel towards the left and will be of opposite polarity than the input signal. Since it travels towards the left, it is amplified by all the tubes of the second stage only towards the left and therefore ends in the reverse termination of the plate line of the second stage. The signal components that went towards the right in the plate line of the second stage will be out of phase and will appear at the grids of the third stage as separate pulses of much smaller amplitude than the desired signal and of opposite polarity.

The same sort of effect will occur between the plate line of stage 2 and the grid line of stage 3. By a judicious experimental choice of mismatches, it is possible to cancel the effects of the various misterminations, resulting in a clean signal.

The termination of the plate line of the third stage is 360 ohms and the termination of the grid line of the fourth stage is 160 ohms. These respective lines are of the nominal impedances represented by their terminations. It is to be expected, however, that a considerable reflection will occur at the junction of the two lines. This reflection will promptly be absorbed by the reverse termination of the system,

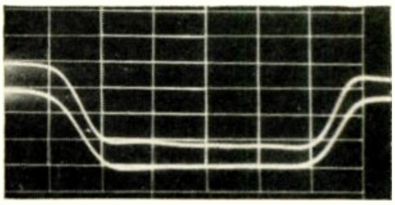


FIG. 3—Input waveform to amplifier with 10^{-9} sec rise time and output waveform (bottom) with maximum gain

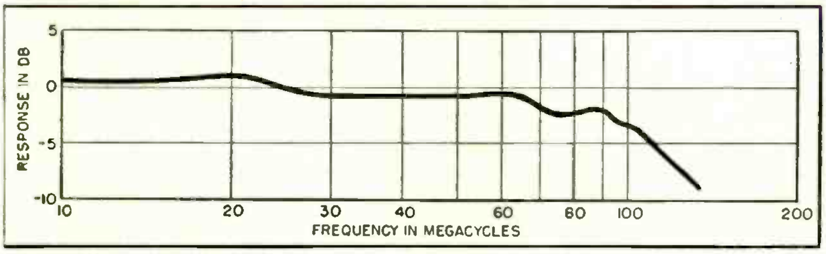


FIG. 4—Frequency characteristic of amplifier in the range of 10 to 200 mc

namely the left termination for the plate line. This is much like a tapered line and the advantage of greater net gain into the load holds here also.[1]

Tube Types

Three types of tubes are used, the 6AH6, 6AK5 and 6CB6. Type 6AH6 is used as input tube because of its high g_m/I_p ratio for the absolute value of g_m used. A high value of g_m is needed since the first stage operates with negative-going signals and g_m therefore decreases with the signal. The high input capacitance of the 6AH6 was no objection in this case, due to the nominal 160-ohm input impedance of the system. The low cathode resonant frequency is no objection either, since the maximum frequency of interest is approximately 120 mc.

Since the 6AH6 has an output capacitance of 2 $\mu\mu$f, it was desired to follow it by a stage with comparable input capacitance. The 6AK5 fits this situation best. Since its output capacitance is not much different from its input capacitance, the third stage is an iteration of the second stage.

The problem for the last stage was to use a tube with greater current-handling capability than the 6AK5 to develop at least 5 volts across 80 ohms, or approximately 63 ma of peak current. It was not desirable that this tube have as large an input capacitance as the 6AH6 and the 6CB6 seemed a satisfactory compromise.

By working the tubes well below their ratings, and with the alternatively low and high biases needed in the system, the choice of tubes indicated above led to approximately 4 tubes per stage. This number simplified construction of the artificial transmission lines and was not too high to exclude lining up the tubes in a single row approximately 17-in. long, which is the maximum length that can be fitted into a 19-in. rack.

The various tubes are operated far below their maximum ratings. Because of this, it was found unnecessary to select tubes for any of the amplifiers constructed. A modification of the amplifier, decreasing cathode bias and increasing screen voltages, was made to run the tubes harder. The amplifier gain was thereby increased from 36 db to 40 db.

Gain Control

To provide control over the total gain of the amplifier, the last stage is operated at a variable grid bias. Figure 2 shows that the gain can be varied over a range of approximately 24 db by this method. This type of control is more desirable than the type which attenuates the signal by a potentiometer, since the signal is not varied, but rather, the gain of the amplifier tubes.

While it was anticipated that the amplifiers would be operated from a-c lines having a regulation of better than 0.1 percent, additional protection was provided by regulating the screens of the tubes by a glow-discharge tube. The large cathode resistors also help.

Low-frequency compensation is provided by the R-C combination in the grid line of the second stage. This is a more desirable method than that of providing larger coupling capacitors between lines, or by connecting grids individually by capacitors to the grid delay lines.

Power Supply

The amplifiers are operated from a regulated a-c line, the plate supply is therefore left unregulated and consists of a simple choke-input rectifier. A small amount of decoupling between stages was found to be desirable, especially in the high-gain versions of this amplifier.

The pulse performance of the amplifier as observed on a wide-band oscilloscope is shown in Fig. 3. The upper trace is the input to the amplifier and the lower trace the output at maximum gain. The output waveform was taken with an attenuator between the amplifier and the oscilloscope. The input pulse for these photographs was derived from a mercury switch pulser, with a rise time of the order of 10^{-9} sec. The oscilloscope did not have as good a rise time as this and the input pulse is therefore smeared out. The sweep speed for these pictures is 10^{-8} sec per division. The measured rise time of the amplifier, from these pictures, is 4.3×10^{-9} sec.

Figure 4 shows the frequency response of the amplifier in the range of 10 to 200 mc. Several small discontinuities will be noticed, but these are relatively immaterial insofar as the pulse response of the amplifier is concerned.

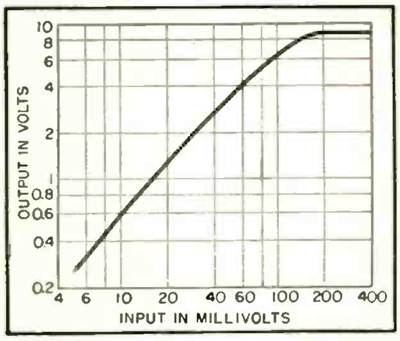


FIG. 5—Linearity curve of amplifier

Figure 5, a plot of input vs output amplitude, shows that the linearity of the unit is quite good up to an output of approximately 8 volts. This is more than adequate for operating scalers and coincidence circuits.

This work would not have been possible without the diligence and experimental design efforts of Anatol Adveenko, nor without the support of the AEC.

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(2) W. H. Horton, J. H. Jasberg and J. D. Noe, Distributed Amplifiers, *Proc IRE*, 38, p 748, July 1950.

Stabilizing Color Carrier

Self-balancing phase detector achieves stability by combining time gate and synchronous detector with bipolar detector to minimize factory alignment as well as field servicing of color reference oscillator. Circuit also includes color-kill output for monochrome reception

By E. G. CLARK

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SYNCHRONOUS DETECTORS used for high-sensitivity phase detection have suffered in past applications from phase instability produced either by supply-voltage or gating-voltage variations. Although conventional balanced-diode phase detectors have desirable characteristics, their usable sensitivity depends upon exactness of balance and level of input signal.

The self-balancing phase detector described below has proved successful in prototype color television receivers wherein it serves to maintain the color reference oscillator to a tolerance better than that required by perception of the ordinary viewer.

Balanced Diode Detector

The principal advantage of a balanced form of phase detector in a high-quality automatic phase-control system lies in the immunity it provides to amplitude variations in the comparison signals. To better understand the ultimate circuit development the parameters controlling balance and the effects of unbalance in the familiar dual-diode phase detector are reviewed briefly.

Figure 1 illustrates a conventional circuit in which the oscillator output is applied in parallel across the diodes and the higher-amplitude gated burst is applied in push-pull. In order that the output be maintained at zero at phase center, the d-c voltages produced by each diode must be equal over the required range of signal variations.

This condition requires that the opposite polarity burst signals be of equal amplitudes and source impedance, the diodes be of equal efficiency as peak detectors and that the oscillator signal have peak voltage symmetry about the average level. These requirements can be most conveniently met with a series of balancing controls. If an exactly balanced burst transformer proves too expensive or too low in impedance, adjustment of the relative inductance of the two halves of the secondary can assure a balanced burst input. With the input signal effectively balanced, final balance is provided by adjustment of the relative resistance of the diode leaks.

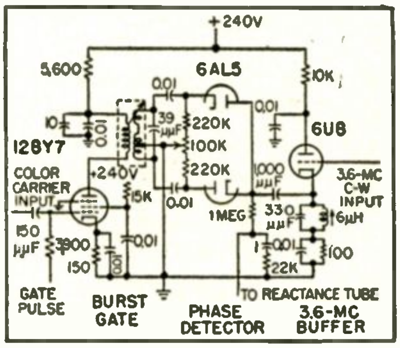
+240V
5,600
6AL5
10K
0.01
39 μμF
220K
100K
220K
0.01
6U8
10
0.01
12BY7
COLOR CARRIER INPUT
+240V
15K
0.01
1,000 μμF
3.6-MC C-W INPUT
1MEG
330 μμF
6μH
150 μμF
3900
0.01
150
100
1
0.01
22K
100
GATE PULSE
BURST GATE
PHASE DETECTOR
TO REACTANCE TUBE
3.6-MC BUFFER

FIG. 1—Conventional circuit with inputs in parallel and push-pull

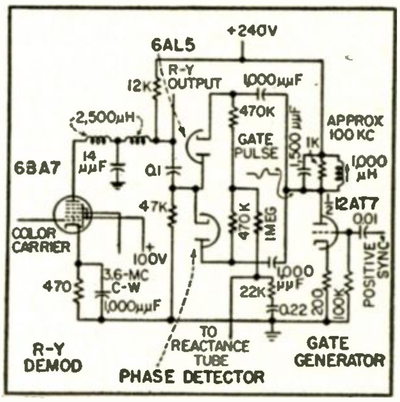
+240V
6AL5
R-Y OUTPUT
12K
1,000μμF
2,500μH
470K
GATE PULSE
1,500 μμF
1K
APPROX 100 KC
1,000 μH
6BA7
14 μμF
0.1
47K
470K
1MEG
12AT7
0.01
COLOR CARRIER
100V
3.6-MC C-W
1,000μμF
470
1,000 μμF
22K
0.22
200
100K
POSITIVE SYNC
R-Y DEMOD
TO REACTANCE TUBE
PHASE DETECTOR
GATE GENERATOR

FIG. 2—Error voltage with time gating and d-c reinsertion

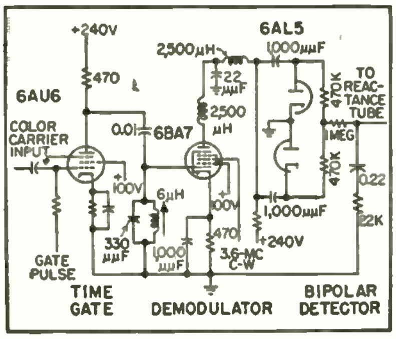
+240V
6AL5
2,500μH
1,000μμF
470
22 μμF
6AU6
2,500 μH
470K
TO REACTANCE TUBE
COLOR CARRIER INPUT
0.01
6BA7
1MEG
470K
0.22
100V
6μH
100V
1,000μμF
22K
470
330 μμF
1,000 μμF
+240V
3.6-MC C-W
GATE PULSE
TIME GATE
DEMODULATOR
BIPOLAR DETECTOR

FIG. 3—Bidirectional control voltage unaffected by supply variation

Unbalance Conditions

Unbalance in the phase detector will introduce a steady-state phase error variation with burst or oscillator-voltage amplitude changes, produce asymmetrical pull-in and impair the noise-rejection of the system. Unbalance also restricts the maximum usable loop gain and hence to a large degree determines the overall system performance. In addition to the quality of balance, another important limitation to the upper sensitivity of this form of phase detector is in the available amplitude of input signals.

If the desired loop gain indicates a phase detector sensitivity of 20 volts per radian, for example, an oscillator signal of 40 volts peak-to-peak and a substantially greater burst signal will be required. Obtaining such high-amplitude signals becomes a problem since it must be accomplished without raising the resonant impedance of the 3.58-mc circuits through the use of dangerously high Q's. Because of the substantial heat rise of a color receiver, phase errors introduced by thermal drift in these circuits must be minimized through the use of low Q as well as temperature stabilization.

This condition is particularly

true when a typical system employing this form of phase detector may have as many as five tuned circuits outside the apc loop. The shielding and layout problems are also made more difficult at high levels of color-carrier frequency signals.

Synchronous Detectors

Employing a synchronous detector for phase detection has certain philosophical advantages besides offering the possibility of simplification. The use of a circuit similar to the color demodulator, but with a d-c plate load, provides a substantial reduction in the number of independent 3.58-mc tuned elements, improves noise performance at fractional signal-to-noise ratios, solves most of the a-c balance problems and makes it possible to achieve burst separation by direct time-gating of the detector. With the exception of the last item, these are generic advantages of synchronous detectors discussed below.

While direct coupling is a convenient technique in several respects, it introduces a stability problem. In such a system, variations in supply voltages, static tube characteristics, component values or gate pulse amplitude will generate a d-c output and contribute to a steady-state phase error. Further complication is introduced because the output is referenced to the plate supply voltage instead of ground. While systems of this type have been employed, it is felt that their long-term stability must be improved before they can be commercially successful.

Use of a color demodulator as a phase detector is worthy of consideration since such a system retains many of the advantages of synchronous detectors and likewise includes the *R-Y* demodulator in the apc loop. Like the direct-coupled system, however, the practical difficulties are severe. To separate the demodulated burst from the color difference signal, an a-c coupled time gate appears mandatory. The a-c coupling provides freedom from the sources of drift previously outlined, but introduces the requirement for re-establishing the phase center reference voltage independently of color-carrier modulation.

A circuit that combines generation of a bidirectional error voltage with time gating and d-c reinsertion is illustrated in Fig. 2. The gating waveform is a single sinusoid generated by the ringing circuit tuned to a line-frequency harmonic and driven by horizontal sync. The diodes will then conduct in sequence at blanking and burst times and read the relative voltage difference independently of modulation. The diode and gate pulse balance characteristics therefore control the performance and stability. The circuit has balance problems analogous to those of the conventional balanced diode circuit translated to a lower frequency but with additional complications involving color killing, burst suppression and the location of contrast and chroma controls.

Self-Balancing System

The basic circuit of the self-balancing phase detector system contains three functional blocks: a time gate, a synchronous detector and bipolar detector. The time gate, or burst separator, is a coincidence gate enabled during burst time. Its output is coupled to the synchronous detector through a filter that removes the gating frequencies. The plate load of the synchronous detector is a low-pass filter of sufficient bandwidth to produce a reasonable replica of the demodulated burst envelope. By a-c coupling to a bipolar detector, the required bidirectional control voltage is generated with complete freedom from supply voltage variations. This configuration is illustrated by a typical circuit in Fig. 3.

Operation is based on the recovery of the burst envelope at the synchronous detector plate. This envelope will be zero when the burst and reference voltages are in quadrature, but will assume a polarity determined by the direction of any phase deviation from quadrature and an amplitude determined by the magnitude of this deviation. The bipolar detector consists of two oppositely poled peak detectors whose outputs are combined through isolating resistors.

Bipolar Output

For a given phase deviation, the diodes read the difference between the positive and negative peaks of the pulse train and produce a d-c output equal to half the difference, with the loss resulting from the required isolation. Because of the short duty cycle of the demodulated burst, the bipolar detector efficiency comes close to the theoretical maximum of 50 percent. Because the a-c input to the bipolar detector vanishes at phase center, zero d-c output is assured without requiring a balance of tube characteristics, signals or supply voltages.

In addition to providing inherent static (synchronous) balance, this configuration allows utilization of many of the practical advantages of the synchronous detector. These include the immunity provided the demodulated burst for a wide range of variation in amplitude and harmonic content of the reference c-w and makes it feasible to provide an electron-coupled oscillator to drive the *R-Y* demodulator and the burst demodulator in parallel.

Inclusion of the *R-Y* demodulator drive in the apc loop improves overall stability and use of the eco simplifies the system through the elimination of any buffer requirement. Because the gain in the system is at burst-envelope frequencies, stability is further enhanced through the substantial reduction in burst level and the number of color-carrier-frequency tuned elements. This characteristic is also important since it makes possible achievement of extremely high sensitivities by inserting additional amplification between the synchronous and the bipolar detectors.

It is shown that amplifiers with particular characteristics can be employed to control the performance of the entire system. The sensitivity of the simple system of Fig. 3 is comparable to the balanced-diode system although dependent on burst amplitude.

Dynamic (asynchronous) balance is not inherent with this system and precautions must be taken in the design to assure acceptable dynamic characteristics. Symmetrical pull-in and elimination of noise cross-modulation are achieved without special requirements for diode balance if the synchronous detector is sufficiently linear. The linearity requirements established for the color demodulators are more than adequate for the burst demodulator.

Sensitivity

Figure 4A is a block diagram of a self-balancing phase detector system employing a linear voltage amplifier between the synchronous and bipolar detectors, with waveforms indicated for asynchronous or open-loop operation. The output of the synchronous detector is a series of pulses whose tips describe the sinusoidal beat note between the burst and reference c-w signals. This signal is amplified before the beat frequency is recovered by the bipolar detector and attenuated in the filter by the amount m, which is the ratio of a-c to d-c transmission of the filter. The sensitivity μ of the phase detector system is given by

$$\mu = \partial E/\partial \phi \text{ volts per radian.}$$

This is the slope at phase center of the open-circuit bipolar detector a-c output waveform or d-c output characteristic, the two being identical in the absence of the filter. If the bipolar detector has an efficiency of 50 percent, the following relation can be written in terms of E, the input beat note in peak-to-peak volts.

$$\mu = (E/4) \sin \phi \text{ at } \phi = 90 \text{ deg, phase center} = E/4 \text{ volts per radian}$$

Phase detector sensitivity is therefore a direct function of the amplitude of beat note supplied to the bipolar detector. Sensitivity can be increased with equal reliability by either increasing the conversion gain of the synchronous detector or by the addition of amplification to follow it.

Cascode Demodulator

In the course of the work on a higher-gain demodulator, a twin-triode circuit was developed that has characteristics particularly suited for this application. The circuit is an adaptation of a signal multiplier having a configuration resembling the cascode amplifier.

Briefly, it consists of two triodes connected in a-c series, that is, with the plate of the first driving the cathode of the second and with color-carrier and reference carrier applied to the first and second grids respectively. Typical circuits have delivered up to 100 volts peak-to-peak of linear demodulated output with a burst input of about 6 volts.

An important feature of this configuration is the use of two series elements with a frequency-selective intrastage coupling. This makes it possible to employ time gating of the burst in the first section and remove the gating frequency by the intrastage selectivity before demodulation is performed in the second section. Such an operation is impractical in conventional pentode or heptode demodulators because of the difficulty in removing gating frequencies from the space current once introduced at the first grid.

To justify the usefulness of even greater phase-detector sensitivity, it is necessary to examine its role in determining the loop performance. The following expression can be written for the d-c loop gain f_c

$$f_c = \mu\beta \text{ cycles per second}$$

where μ is the phase detector sensitivity in volts per radian and β is the reactance tube sensitivity in cycles per volt. Gain f_c has the dimensions of frequency and is also the expression for the maximum possible frequency deviation from which the system could pull in were it not for the gated nature of the input. Higher values of μ make possible a design choice between a higher loop gain or redistribution of reactance tube and phase-detector sensitivities for a given loop gain.

The latter is of importance in determining the stability of the complete system. Direct-current degeneration in the reactance tube produces a substantial improvement in stability by increasing its immunity to tube and supply voltage changes, but is permissible only to the degree that the loss in loop gain can be regained through the use of a higher phase-detector sensitivity. A sensitive, inherently balanced phase detector system can therefore contribute to the stability of the complete system in a twofold manner.

Phase Error

The primary function of the apc system is to hold the phase difference between the locally generated c-w reference signal and the synchronizing burst within a prescribed amount. The steady-state phase difference θ_{ss} is determined by the open-loop frequency deviation Δf between the burst and reference c-w and the d-c loop gain of the system

$$-\sin \phi_{ss} = \frac{\Delta f}{f_c}$$

Although the phase error will continue to decrease as the loop gain is increased, the point of diminishing returns is reached when the resulting hue distortion falls below the perceptible level. While a reduction in the close tolerances to which certain components outside the apc loop must be held may indicate the usefulness of higher d-c loop gains than usually provided, exceedingly high loop gains are not generally necessary to meet the phase accuracy requirements of a typical color television receiver. In some monitoring or laboratory equipment the high sensitivity may be useful for precision applications.

A second important performance characteristic of the apc loop is the degree of random phase fluctuation produced in the output by the presence of thermal noise in the burst. The effective integration of the detected phase fluctuations by the phase detector filter is modified by the a-c loop gain. It is conventional to express the effect of the loop on noise in terms of the bandwidth f_{nn} of the rectangular filter that will pass the same noise power. Richman[1] has shown this to be

$$f_{nn} = \frac{\pi}{2}\,(mf_c + f_2)$$

where f_2 is the frequency at which the attenuation of the filter is 3 db less than the infinite frequency attenuation. To minimize the subjective effect of random phase fluctuations produced by noise, it is necessary to limit f_{nn} to a value where video noise will mask these disturbances. If the noise bandwidth is assigned a maximum value and f_2 chosen for an optimum passband shape, the a-c loop gain mf_c must be held constant. Accordingly, increasing the d-c loop gain will have an adverse effect on noise performance unless the a-c gain is restored to its original value by decreasing the ratio of a-c to d-c transmission of the filter.

Pull-In Time

When the synchronous characteristics of the apc loop are designed for minimum phase error from all sources, the system performance is limited by the asynchronous characteristics, principally pull-in time. The additional parameter, K, which helps determine pull-in time can be expressed in terms of a-c loop gain and the time constant, xRC, of the shunt arm of the apc filter.

$$K \cong \frac{\pi}{2}\,(mf_c \times xRC)$$

$$\cong 0.25(mf_c/f_2)$$

The noise bandwidth expression can now be rewritten as

$$f_{nn} = \frac{\pi}{2}\left(mf_c + \frac{mf_c}{4K}\right)$$

$$= \frac{\pi}{2}\,mf_c\left(\frac{K + 0.25}{K}\right)$$

The following expression has been developed[1] for pull-in time T_f in terms of these parameters

$$T_f = \left(\frac{\pi}{2K}\,\Delta f\right)^2 \left(\frac{K + 0.25}{f_{nn}}\right) > 4\,\frac{\overline{\Delta f^2}}{f_{nn}{}^3}$$

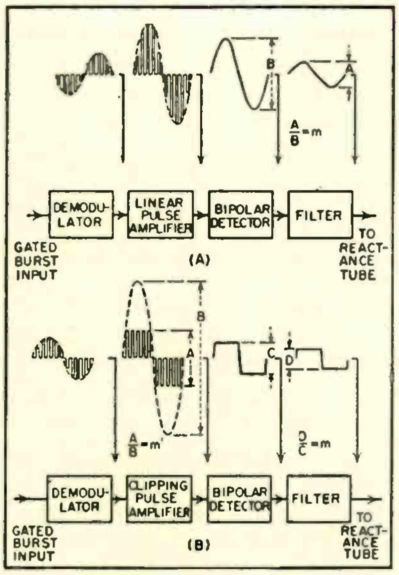

FIG. 4—Self-balancing phase detector (A) using clipping amplifier (B)

This expression has been used to determine the optimum value of K and to demonstrate that the limit on minimum T_f for large values of Δf is approached as the d-c loop gain is increased, provided mf_c is constant. It is the increase in pull-in range for a given pull-in time that constitutes one of the important reasons for seeking higher d-c loop gains.

Clipping Amplifier

The maximum limit on sensitivity of the systems so far described is set by the simple expression $\mu = E/4$ volts per radian where, in order to preserve asynchronous balance, the peak-to-peak beat note E must be linear. The maximum limit on beat note amplitude is less than the B-supply of the receiver. Figure 4B is a block diagram of a system that can achieve virtually unlimited sensitivity by substituting a symmetrically clipping amplifier for the linear amplifier driving the bipolar detector. The dynamic balance requirements can be met as long as the beat note waveform generated by the bipolar detector is symmetrical, with no d-c component. The sensitivity is directly proportional to the amplification that precedes the symmetrical clipping and is not limited by beat note amplitude. The waveforms of Fig. 4B illustrate another important characteristic of this system, the difference in a-c and d-c gains.

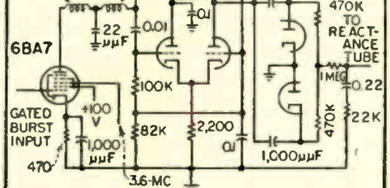

FIG. 5—Cathode-coupled twin-triode clipper has gain of twenty

The d-c sensitivity, as before, is given by the slope at phase center of the open-circuit bipolar detector a-c waveform or d-c characteristic. Over a restricted phase range this slope increases with amplification independently of the clipping action. The a-c or asynchronous gain is determined not by the slope but by the amplitude of the beat note and therefore by clipping level. As shown in Fig. 4B, the a-c to d-c gain ratio m' of the system can be taken as approximately the ratio of the amplitudes of the actual amplifier output to the unlimited output as given by the product of the input amplitude and the small-signal amplification.

The error introduced by the differences in area for a given amplitude of limited and unlimited beat note is in the direction to increase m', but is sufficiently small to be unimportant. In determining the a-c loop gain of the system, the cascaded effects of m and m' must be considered, although some complication is introduced by the variation of m' with level of input signal.

A typical circuit embodying the clipping beat-note amplifier is illustrated in Fig. 5. A 12AT7 tube is employed as a cathode-coupled twin-triode clipper with a small-signal gain of approximately twenty times. The sensitivity of this phase detector system is approximately 150 volts per radian with an m' of 0.16. This circuit, employed in a prototype color receiver, required no phase adjustment during transportation and experiments over a period of two and a half months. At the end of this time, the phase error was checked and found to be within the accuracy to which it had been originally adjusted to optimum.

While the synchronous characteristics of this system can be regarded as excellent, the improvement in asynchronous performance is subject to two limitations. First, the actual improvement in pull-in time over low-gain systems is somewhat less than 50 percent. Second, the values of d-c loop gain employed require an a-c to d-c gain ratio of approximately 0.001 for the system. Although no disadvantage in itself, the high a-c attenuation accentuates the difficulty in maintaining symmetrical pull-in characteristics through reduction of the tolerable d-c component generated by imperfect clipping symmetry. The point of diminishing returns is reached rapidly when improvement in overall system performance is sought by very high d-c gain.

Two-Mode Systems

The d-c component generated by asymmetry in the clipping beat-note amplifier has been shown to be a limiting factor in determining maximum usable d-c gain. It can be turned to useful application in one of the simpler forms of a two-mode apc system. Two-mode systems are of interest since they represent a practical means for achieving very high system performance. Several forms of two-mode systems are particularly suited for use with the self-balancing phase detector.

One of the techniques for achieving different modes of operation for the synchronous and asynchronous operation is to employ a nonlinear filter. Such action can be produced by modifying the clipping beat-note amplifier to have a deliberate asymmetry (nonlinearity) at a given amplitude level. If this level lies between the amplitudes of the thermal noise fluctuations and the beat note a large d-c component will be generated whenever beat note is present. This d-c component is unidirectional and will speed oscillator pull-in in one direction only, so a prerequesite for this form of two-mode device is offset frequency operation. Offsetting the free-running oscillator frequency will assure the required unidirectional frequency difference but will also generate a steady-state phase error. The high d-c gain requirement is retained by such a system merely to maintain this phase error within acceptable limits. Another limitation is the ambiguity that can exist between noise and beat-note amplitudes at low signal-noise ratios.

Frequency Detection

An elegant form of two-mode device is one that employs a phase servo to control sysnchronous performance and a frequency servo to control asynchronous performance. Such a system can be designed around an apc loop supplemented by the form of beat-frequency discriminator that Richman[2] has called the quadricorrelator. The form of quadricorrelator having maximum number of degrees of freedom and hence the highest performance employs two synchronous detectors operating in quadrature. The presence in the self-balancing phase detector system of many of the elements required for the quadricorrelator makes the combination appear particularly attractive.

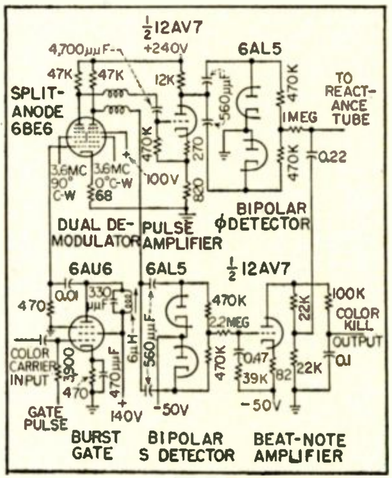

FIG. 6—Ultimate two-mode phase detector with variable a-c gain and color kill

A complete quadricorrelator circuit was designed to obtain an evaluation against other forms of two-mode systems. The circuit was simplified by substituting a passive filter and a dual-diode sum-and-difference detector for the summing synchronous detector. The performance advantages and mode of operation of the resulting circuit are closely analogous to those of the self-balancing phase detector. Further simplification was made possible by developing an experimental dual demodulator tube that can, in one envelope, perform the functions of the two quadrature synchronous detectors. Employment of this circuit is deferred in preference to another described below, which provides the advantage of automatic color killing.

Synchronization Detection

Two synchronous detectors in quadrature can be utilized in a circuit named the d-c quadricorrelator and described[2] in the literature. The so-called S detector operating in quadrature with the phase detector will produce a maximum d-c output when the system is in synchronization and zero d-c output when synchronization is lost. This change in d-c voltage can be utilized to switch off and on an amplifier that provides a shunt path for the beat note around the phase-detector filter.

The effect is to produce a variable a-c gain, which is maximum for the asynchronous condition facilitating rapid pull-in and minimum for the synchronous condition, producing minimum noise bandwidth. A narrow-band filter on the output of the S detector increases the noise immunity of the switching voltage. Since the d-c output of the S detector requires the presence of burst, this voltage may be used to provide automatic color killing.

Figure 6 is the schematic of a two-mode phase-detector system employing variable a-c gain and automatic color killing. The experimental dual demodulator tube is employed to provide the quadrature burst demodulation. Two dual diodes comprise the bipolar S and ϕ detectors. A linear pulse amplifier provides a high d-c sensitivity. The beat-note amplifier also serves the additional function of amplifying the color-killing voltage before application to the chroma amplifier. Relative complexity of the phase-detector system is partially offset by elimination of special buffer requirements for the oscillator.

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(2) Donald Richman, The D-C Quadricorrelator: A Two-Mode Synchronization System, *Proc IRE*, 42, 1, p 288.

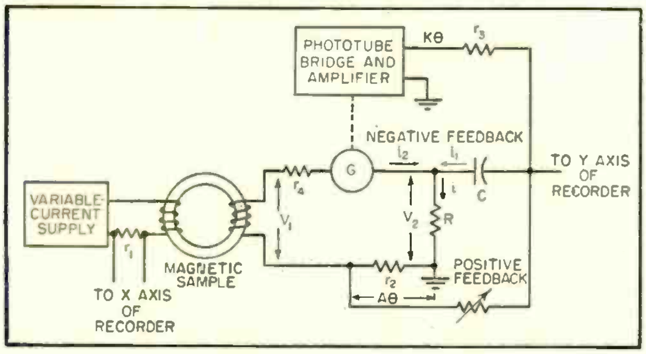

FIG. 1—Simplified circuit of fluxmeter showing feedback paths

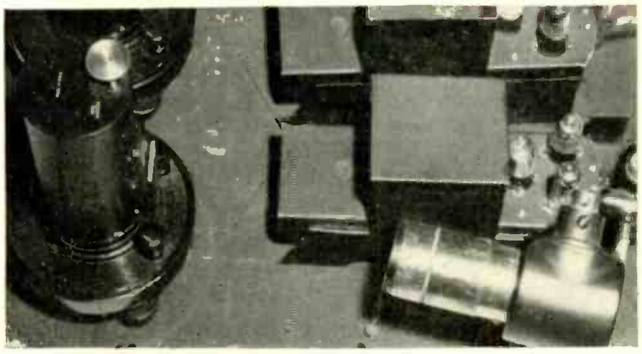

FIG. 2—Galvanometer deflects light to phototubes in shielded box

Recording Fluxmeter

High-sensitivity instrument plots B-H curve of magnetic materials in few minutes. Ease of operation enables unskilled operators to obtain accurate results. Overall error in measurement is 0.5 percent ± 25 flux interlinkages per minute

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DEVELOPMENT of a recording fluxmeter for tracing d-c magnetization curves outmodes use of ballistic galvanometers for obtaining hysteresis loops of magnetic materials.

The fluxmeter described in this article is similar to that developed by Cioffi[1], which employs one or two integrators and a two-axis recorder for tracing B-H curves directly on standard coordinate paper. The search coil wound on the sample requires only a few turns of wire because of the sensitivity of the instrument.

Theory of Operation

The principle of operation of the fluxmeter may best be understood by reference to Fig. 1. Two coils are wound on a ring sample of magnetic material. The primary is excited with slowly varying direct current which causes a voltage drop across r_1. The movement of the recorder pen in the X direction is thus proportional to the current in the primary coil and consequently the magnetizing force.

As shown in Fig. 1, any change of magnetic flux in the sample will induce a voltage in the secondary coil causing a deflection in the galvanometer. The mirror of the galvanometer, which had previously illuminated two phototubes equally, will then direct more light on one phototube than on the other generating an error voltage in the bridge circuit of which the phototubes form a part. This error voltage is amplified and fed back into the galvanometer circuit through the capacitor to reduce the galvanometer deflection. The output of the amplifier, which is the integral of the voltage induced in the secondary coil and thus proportional to the flux in the sample, is applied to the Y axis of the recorder. The behavior of the galvanometer coil is described by

$$I\frac{d^2\theta}{dt^2} + b\frac{d\theta}{dt} + k = ge \qquad (1)$$

where θ is the angular deflection of the galvanometer coil, I is the moment of inertia of the coil, b is the total mechanical and electromagnetic damping torque, k is the torque due to the suspension and ge is the torque due to the voltage e appearing across the galvanometer.

The voltage e is given by

$$e = v_1 - v_2 + A\theta \qquad (2)$$

where v_1 is the voltage generated in the secondary by a change in flux in the sample, v_2 is the voltage across R and $A\theta$ is a positive feedback voltage appearing across r_2.

If the total stray capacitance loading the phototubes is small, for small deflections of the galvanometer the output voltage of the amplifier is $K\theta$, where K is the overall gain of the phototubes and electronic amplifier. The output impedance of the amplifier is represented by r_3.

If the currents are as marked in Fig. 1

$$K\theta = i_1 r_3 + \frac{1}{C}\int i_1\,dt + v_2 \qquad (3)$$

$$K\theta = \frac{r_3}{R} v_2 - \frac{r_3}{r_4} e + \frac{1}{RC} \int v_2\, dt - \frac{1}{r_4 C} \int e\, dt + v_2 \qquad (4)$$

where r_4 is the internal galvanometer resistance.

Differentiating and rearranging

$$v_2 + C(R + r_3) \frac{dv_2}{dt} = RCK \frac{d\theta}{dt} + \frac{RCr_3}{r_4} \frac{de}{dt} + \frac{R}{r_4} e \qquad (5)$$

The voltage output of the search coil is given by

$$v_1 = N 10^{-8}\, d\theta/dt \qquad (6)$$

Substituting Eq. 2 and 6 in 1 and rearranging

$$v_2 = - \frac{I}{g} \frac{d^2\theta}{dt^2} - \frac{b}{g} \frac{d\theta}{dt} - \frac{k}{g} \theta + N 10^{-8} \frac{d\phi}{dt} + A\theta \qquad (7)$$

Differentiating Eq. 7

$$\frac{dv_2}{dt} = - \frac{I}{g} \frac{d^3\theta}{dt^3} - \frac{b}{g} \frac{d^2\theta}{dt^2} - \frac{k}{g} \frac{d\theta}{dt} + N 10^{-8} \frac{d^2\phi}{dt^2} + A \frac{d\theta}{dt} \qquad (8)$$

Substitution of Eq. 7 and 8 in 5 gives

$$\left[\frac{RCr_3}{r_4} + C(R + r_3)\right] \frac{I}{g} \frac{d^3\theta}{dt^3} + \left\{\left[\frac{RCr_3}{r_4} + C(R + r_3)\right] \frac{b}{g} + \left(\frac{R}{r_4} + 1\right) \frac{I}{g}\right\} \frac{d^2\theta}{dt^2} + \left\{\left[\frac{RCr_3}{r_4} + C(R + r_3)\right] \frac{k}{g} + \left(\frac{R}{r_4} + 1\right) \frac{b}{g} - C(R+r_3)A + RCK\right\} \frac{d\theta}{dt} + \left[\left(\frac{R}{r_4} + 1\right) \frac{k}{g} - A\right]\theta =$$

$$N 10^{-8} \frac{d\phi}{dt} + C(R + r_3) N 10^{-8} \frac{d^2\phi}{d^2t} \qquad (9)$$

The measured values of the constants are: $I/g = 1.9 \times 10^{-4}$; $b/g = 1.3 \times 10^{-3}$; $k/g = 1.4 \times 10^{-4}$; $K = 4 \times 10^{4}$; $r_3 = 200$ ohms (approx.); $C = 10^{-6}$ farad; $R = 12$ ohms; $r_4 = 26$ ohms.

The amount of positive of feedback is so chosen that

$$(R/r_4 + 1)k/g - A = 0 \qquad (10)$$

With this condition fulfilled, Eq. 9 is integrated and after substitution of the numerical values of the constants

$$6\times 10^{-8} \frac{d^2\theta}{dt^2} + 3\times 10^{-4} \frac{d\theta}{dt} + 0.5\theta = N 10^{-8}\phi + 2\times 10^{-12} N \frac{d\phi}{dt} + L \qquad (11)$$

where L is the constant of integration.

The first term in Eq. 11 is negligible and the time constant of the system is $3 \times 10^{-4}/0.5 = 6 \times 10^{-4}$ second, therefore the steady state solution is

$$\phi = \frac{K\theta}{N} 10^8 \left[RC + \left(\frac{R}{r_4} + 1\right) \frac{b}{gK}\right] + L \qquad (12)$$

The amplifier output voltage $K\theta$ is applied to the recorder. Thus the pen of the recorder moves proportionally to the amount of flux θ in the sample. The constant of integration L is of no importance since just the length of the pen trace is measured.

Electro-Optical System

The arrangement of the galvanometer and optical system is shown in Fig. 2. When the galvanometer is at balance, an equal amount of light is focused on two closely spaced high-vacuum phototubes. A prism is not used to split the light beam. The light source is a filament heated by direct current to avoid inducing 60-cycle hum into the system.

Provision is made for two integrators. The second is for use with a magnetic potentiometer.

The galvanometer has a 7.1 mm/μv sensitivity, critical damping resistance of 120 ohms, period of 7.4 seconds and coil resistance of 26 ohms.

In order to minimize thermal currents in the galvanometer circuit, all connections are made of clean copper lightly coated with grease to reduce oxidation. Also, the galvanometer and other connections are thermally insulated in copper boxes packed with cotton batting.

Amplifier

The schematic diagram of the galvanometer and amplifier is shown in Fig. 3.

The phototubes are arranged in a bridge circuit with the output of the phototube bridge near ground potential.

The 1U4 preamplifier tube was selected because of its low interelectrode capacitance and filament voltage to avoid capacitative loading of the phototubes. A relay operated by turning on the power supply controls the filament current.

For the servomechanical system to have a small time constant, it is necessary that the output of the amplifier to the capacitor C have a low impedance and r_3 be small. This condition is achieved while employing miniature components by using a type 6AH6 tube operating in its high-transconductance region. The range of control in the high-transconductance region is extended by using a constant-current load tube, also a 6AH6, and by operating the screen at a constant 150 volts above the cathode potential.

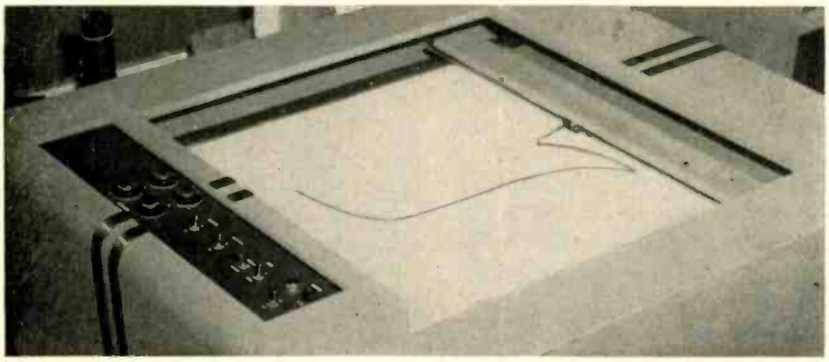
A low-leakage capacitor is used instead of a mutual inductance to oppose the interlinkages of the search coil since high-quality computing-type capacitors are readily available and less power output from the amplifier is required.

Calibration

The total flux in the sample at any moment is given by Eq. 12. Neglecting the constant of integration

$$\phi = 1/N(JK\theta) \text{ gauss} \qquad (13)$$

where $K\theta$ is the output voltage of



Fluxmeter output is applied to electronic plotting board (above) to record B-H curve of magnetic sample under test

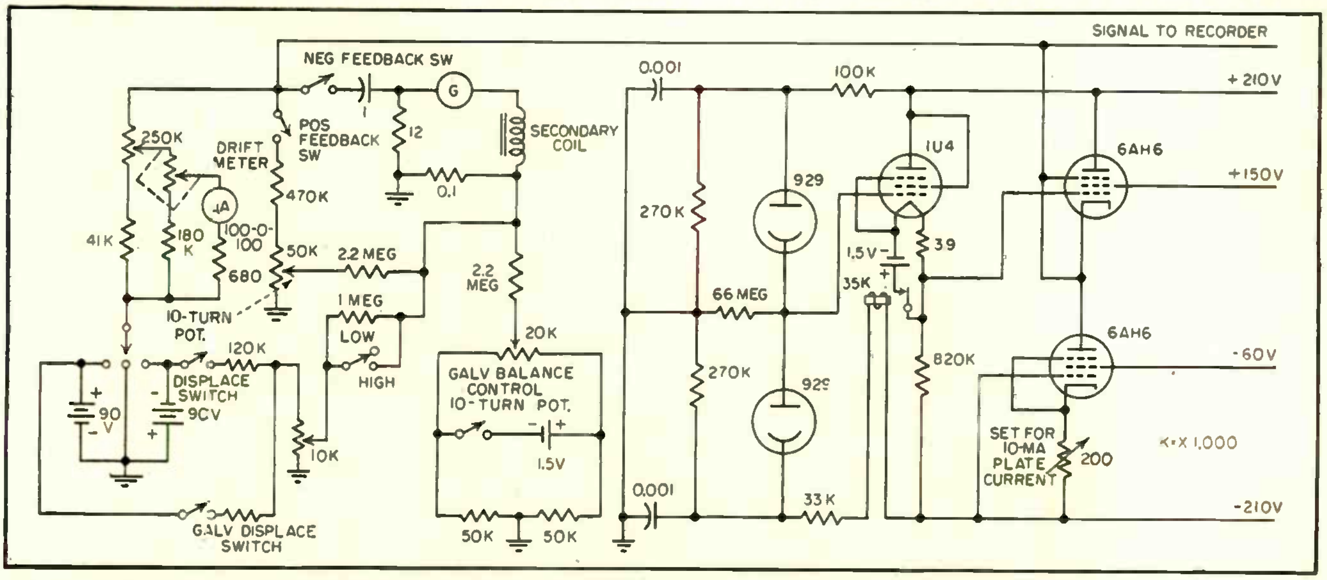


FIG. 3—Load capacitances and leakage currents are kept to a minimum by mounting the photocells and amplifier on the same chassis

the amplifier and J is the calibration constant

$$J = 10^8[RC + (R/r_4 + 1)(b/g)K] \quad (14)$$

The last term in the calibration constant is about 0.5 percent of the first, therefore a change in the gain of the amplifier will affect J only slightly. The values of b, g and K may easily be determined experimentally and $J = 1{,}205$.

The recorder also has a variable scale factor of G cm/volt. An external source of voltage is used to adjust G so that GJ is some convenient number adapted to the scale of the graph paper used. Then

$$\phi = (1/N)(GJ)(K\theta) \times \text{(length of trace on paper)} \quad (15)$$

The H axis of the recorder is calibrated in a similar manner.

Operation

The galvanometer and optical system must be adjusted so that the amplifier output voltage is zero without either positive or negative feedback. Coarse adjustment is made by turning the galvanometer suspension or by moving the phototube chassis while the output-drift meter is at low sensitivity. The galvanometer control potentiometer is then adjusted so that the output-drift meter reads an average of zero at high sensitivity.

The intensity of the galvanometer light is first decreased and then the negative feedback switch is closed. Otherwise, a high transient current will flow at the instant the switch is closed, permanently altering the galvanometer suspension.

The positive-feedback potentiometer is adjusted by displacing the galvanometer to either side of zero using the displacement switches, then adjusting the positive-feedback potentiometer so there is minimum galvanometer drift as indicated on the output-drift meter. The amount of positive feedback required may be different for displacements on opposite sides of zero because of possible mismatching of phototubes. An average of the positive-feedback potentiometer settings on either side of zero is set on the potentiometer.

Considerable galvanometer drift will result if there is a large difference in the amount of positive feedback required when the galvanometer is displaced on either side of zero. In this case, to minimize drift, one of the photocells should be shaded, or both replaced by a more evenly matched pair. If the system goes into oscillation, as may be ascertained by viewing the output of the amplifier on an oscilloscope, the positive-feedback potentiometer is not properly adjusted.

The recorder is then calibrated and the hysteresis curve is traced so slowly that a further decrease in tracing speed does not affect the shape of the curve. Small discontinuities may appear in the recorded hysteresis loop due to rough control of the magnetizing current. A satisfactory source of current is an autotransformer used with a full-wave rectifier and several stages of filtering.

Before switching off the fluxmeter, the negative feedback switch is opened to prevent a heavy transient current from flowing in the galvanometer suspension at the moment of switching.

Accuracy

The degree of accuracy of the fluxmeter depends on the accuracies of the calibration constant, the external calibration voltage and the recorder. In addition, the slow drift of the system due to changing thermal currents and other factors must be considered.

The value of the calibration constant may be obtained within 0.3 percent and the calibration voltage source within 0.1 percent. The static error of the recorder is given as 0.1 percent of full scale. By carefully balancing the fluxmeter, the drift can be restricted to less than 25 flux interlinkages minute. The overall error is then 0.5 percent ±25 flux interlinkages minute.

The sensitivity of the system is easily controlled by adjusting the gain of the recorder. This sensitivity may be increased to such a high degree that the drift error, normally negligible, becomes an objectionable part of the total flux change.

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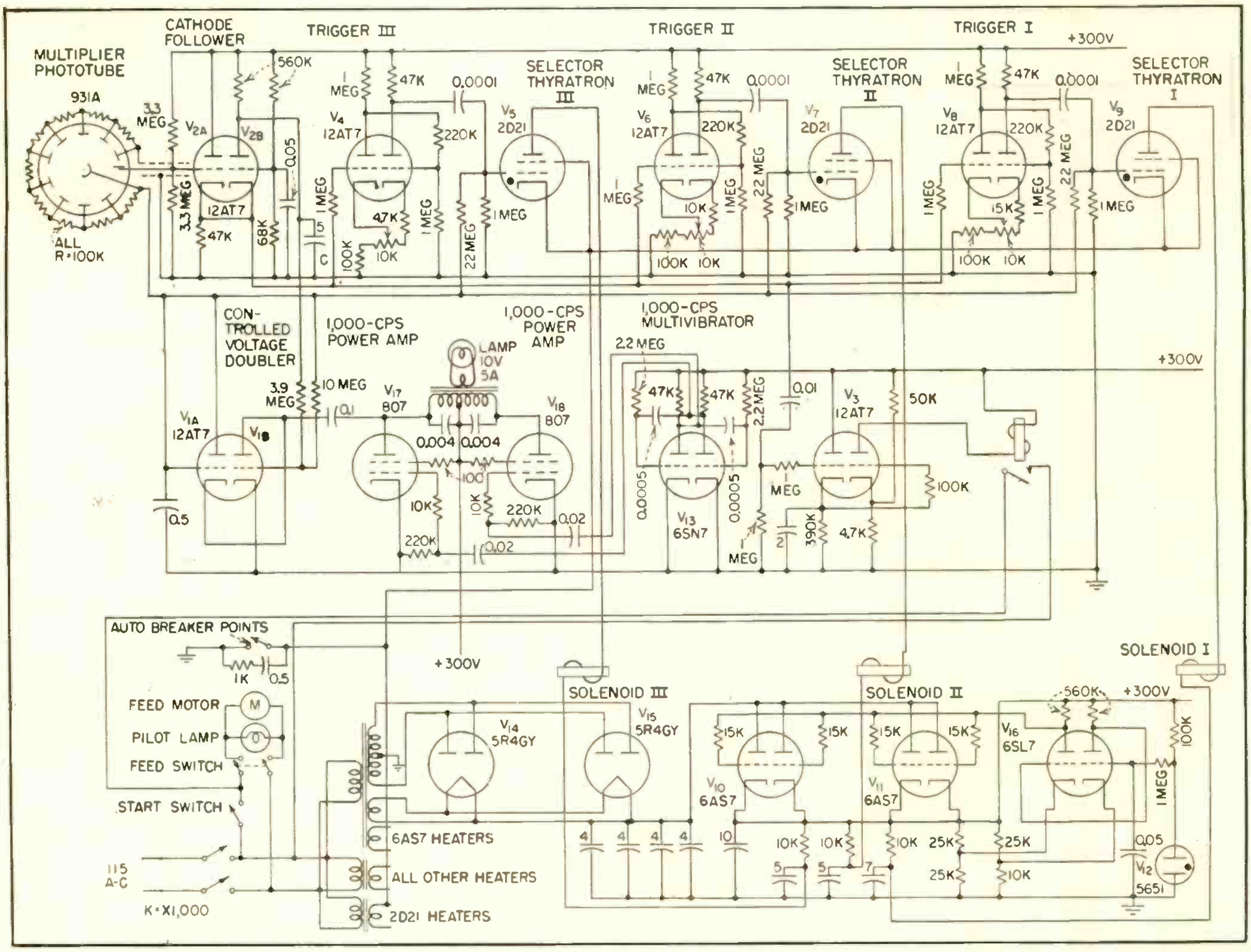

MULTIPLIER PHOTOTUBE
931A
ALL R=100K
CATHODE FOLLOWER
3.3 MEG
V2A
V2B
12AT7
47K
68K
560K
0.05
5
C
TRIGGER III
TRIGGER II
TRIGGER I
+300V
1 MEG
47K
0.0001
V4 12AT7
220K
100K
10K
22 MEG
SELECTOR THYRATRON III
V5 2D21
SELECTOR THYRATRON II
V7 2D21
SELECTOR THYRATRON I
V9 2D21
V6 12AT7
V8 12AT7
15K
CON-TROLLED VOLTAGE DOUBLER
V1A 12AT7
V1B
3.9 MEG
10 MEG
0.1
0.5
1,000-CPS POWER AMP
V17 807
V18 807
LAMP 10V 5A
0.004
100
0.02
1,000-CPS MULTIVIBRATOR
2.2 MEG
V13 6SN7
0.0005
0.01
V3 12AT7
50K
390K
4.7K
2
AUTO BREAKER POINTS
1K
FEED MOTOR
M
PILOT LAMP
FEED SWITCH
START SWITCH
115 A-C
K=X1,000
SOLENOID III
SOLENOID II
SOLENOID I
V14 5R4GY
V15 5R4GY
V10 6AS7
V11 6AS7
V16 6SL7
560K
25K
V12 5651
6AS7 HEATERS
ALL OTHER HEATERS
2D21 HEATERS
4
10
7

FIG. 1—Complete circuit diagram of electronic pencil lead and crayon sorter. Solenoids operate selector fingers of classification bins. Smallest crayons go past all three solenoids to drop into fourth bin

Photoelectric Gage Sorts

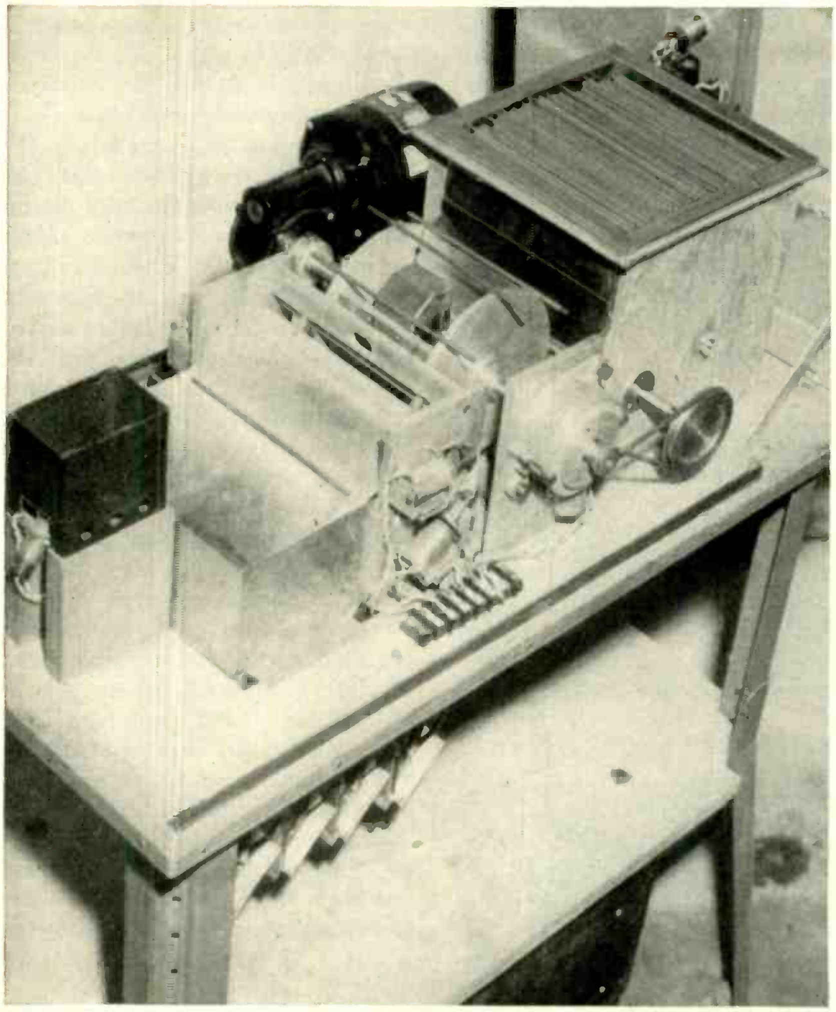
Noncontacting automatic gage measures diameters of fragile pencil leads or crayons as they are whirled through light beam at high speed by motor-driven feed wheel and sorts into four groups differing in diameter by steps of 0.002 inch or even 0.0001 inch

AUTOMATIC GAGING coupled with telemetric controls must rely largely on noncontact measurement because of the time element and the need for long life, trouble-free performance and minimum maintenance.

A pencil sorter is one example of rapid automatic gaging. The problem is to classify pencil crayons or leads according to diameter. These crayons are eventually encased in the usual wooden holder. For proper bond and writing qualities, the insert and holder must have a certain relationship. If the slot in the holder is too large with respect to crayon, the binder may ooze out or may not properly retain the insert; if too small, the crayon may break or be crushed. It is therefore desirable to group the crayons into several sizes and match the appropriate holder to crayon size. The specifications required classifying into four categories differing by 0.002 inch. Several nominal diameters are involved, of which 0.160 inch is typical.

Operation of Sorter

With the automatic sorter, the operator has only to fill the hopper



Machine with cover raised, showing crayon input hopper and feed wheel drive motor at right end of table

Pencil Crayons

By **CARL A. VOSSBERG**

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with pencil crayons or leads and push the start button. A mechanical agitator keeps the crayons in motion to prevent jamming in the hopper. The crayons, picked up one at a time by a motor-driven feed wheel, pass the measuring position at the rate of better than 200 per minute. While in motion they are individually measured by an optical-electronic noncontacting gage. The information is stored to allow time and space for appropriately classifying into one of four categories by means of extending selector fingers. Tolerance limits are adjustable.

When a particular crayon has traversed the selector positions and dropped into its correct bin, the gage is automatically reset in readiness for measuring the next crayon and the cycle is repeated.

The feed wheel has two sets of eight pickup hooks. These are actually standard stainless steel rivets embedded in narrow wheels with the heads protruding. Normally a crayon is picked up by a pair of these hooks. A short or broken crayon will either drop down unobtrusively through the reject slot, be picked up by one hook and then slide into the reject slot, or be thrown back to a small recirculating pile of crayons for another attempt to get on the feed wheel.

If a crayon gets onto a hook on one side, and a later hook on the other side so that it is crosswise, it is dumped back into the recirculating stack by a deflection plate situated between the feed wheels. Thus all crayons are properly aligned for measurement. The efficiency of feed is high, so that only about 1 percent of the hooks are free of crayons.

Classifying Mechanism

As the crayon or lead approaches the measuring station all selectors are reset and closed. It passes a beam of light for only an instant, but this is sufficient for the electronic gage to determine its size. If it is below the lowest limit, the crayon passes all the selectors and drops into the fourth classification bin. If it is within the next larger classification the third pair of selector fingers is actuated by a solenoid and remains open until the pencil has had time to pass through and on to the bin containing that size. A similar action drops still larger crayons into the appropriate bins for the next two larger sizes.

Resetting of selectors is accomplished by a modified Ford breaker and distributor assembly on the feed wheel shaft, opening the thyratron circuits in the electronic classifier.

When the first crayon reaches the measuring station after start-up, a hold relay is actuated and the machine becomes self-running. Should the feed stop for any reason, the relay opens, thereby stopping the feed motor. As a safety precaution a clutch is used between motor drive and feed wheel.

The removable optical aperture in front of a multiplier phototube comprises two slits centered at the edges of the shadow cast by the smallest crayon. The larger the crayon the less light transmitted to the phototube from a lamp and condensing lens source.

To stabilize the electronic system and allow for aging of lamp, phototube and other components, the signal developed when no crayon blocks the beam is automatically regulated to a reference value. Thus, in effect it is a change in the crayon signal from that reference setting that actuates the controlling elements, independently of the conversion gain. This results in excellent stability, requiring no resetting of controls.

Circuit Operation

The basic circuits are given in Fig. 1. The phototube signal output is fed to the grid of cathode follower V_2, which is an impedance converter. The crayon signal is a positive pulse, the peak value being a function of crayon diameter, which may trigger one or more trigger tubes as V_4, V_6 and V_8. The level at which triggering will occur is determined by the cathode circuit controls of the trigger tubes. Trigger tube V_4 will transmit a pulse to thyratron V_5 thus actuating the selector solenoid in its plate circuit, which in turn opens flippers associated with that solenoid to accept the crayon.

The smallest category of crayon will not develop sufficient signal to trigger any of the discriminators. The next size larger will trigger one discriminator, the next will trigger two stages and the largest diameter will actuate all three discriminators and corresponding thyratrons.

Upon completion of the cycle the breaker will open all thyratrons, releasing the selectors and again closing the circuit in readiness for the next signal. The standard eight-point automobile breaker had to be adjusted for minimum open time, since the entire sequence must take place between two adjacent crayons.

The diameter is measured practically instantaneously. To shorten the operate time for the flipper solenoids, a capacitor in each circuit is charged to full supply voltage and then allowed to discharge through solenoid and thyratron. The value of this capacitor is 5 μf each for two stages and 7 μf for the flipper solenoid nearest the measuring station.

A 1,000-cps generator comprising V_{17}, V_{18} and multivibrator V_{13} supplies power for the lamp to ensure constant unmodulated light. The dynode supply voltage is also derived from this generator. A doubler circuit, employing V_{1A} for rectifying the 1,000-cps signal, supplies the dynodes with a d-c voltage whose value is a function of the impedance of V_{1B}. This in turn depends on its grid bias.

Loading pencil crayons into machine for sorting into four different diameter categories

The signal level with no crayon is a minimum and, if less than the reference positive bias on the grid of V_{2B}, capacitor C will discharge on these negative pulses. The greater the minimum phototube signal, the lower the voltage across C and the more negative the bias on V_{1B}, which lowers the dynode supply voltage to correct for the initial change. The gain of the system is such that the minimum voltage (maximum light signal) level is automatically regulated to a precise degree corresponding to a signal output nearly equal to the reference. Voltage for the dynodes then remains independent of the crayons, being solely governed by the unobstructed light-beam intensity resulting in phototube output. Blocking half of the light beam has no perceptible effect on performance since dynode voltages automatically increase to offset the loss in light signal. All couplings are direct, from phototube output to regulating and control tube.

A start switch, paralleling the contacts of the relay in the plate circuit of V_3, operates the feed motor. As soon as the first crayon passes the measuring station, the a-c signal is detected by V_3 and the resultant d-c positive voltage applied to the relay tube section, operating the relay. The feed then is self-running until a prescribed interval without signals, either because of an empty hopper or improper feeding, allows the developed detected voltage to drop off to open the relay, thus stopping the feed. A pilot lamp is used to indicate such action.

A typical electronic power supply regulator is used, employing two 5R4GY rectifiers, two 6AS7's, a 6SL7 and a 5651 reference tube. Tube heaters are unregulated since the automatic gain control can effectively accommodate relatively slow changes in tube characteristics and the like. Even so, the signal output from the phototube is substantial as compared to possible discriminator variations, the limits being about 20 and 150 volts.

Conclusions

An impressive demonstration is to select pencil crayons according to size, with each classification a different color. Then by filling the hopper with these assorted colored pencils it would appear that the machine is a perfect color separator.

No difficulty was experienced sorting into four categories each differing by only 0.0001 inch. The apparent discrimination can be very much enhanced by narrowing the slits.

Applications for classifying on the fly without contact by using the foregoing principles are numerous. For example, nails, screws, rings, washers, disks, cartridges, shells, flints and even transparent glass rods, vials and syringes are adaptable. The latter, because of optical divergence, are relatively opaque when inspected at a reasonable distance.

The mechanical system was designed by E. D. Haffner.

TV Station Monitor

Picture and waveform oscilloscopes show tv broadcast control operator the condition of output signals from studio or equipment as well as incoming signals from networks. Circuits provide pulse cross with vertical sweep expansion to check sync generator

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International Tel. & Tel. Corp.
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TELEVISION MONITORS must be capable of rapidly measuring the video level and picture quality of any signal that may be encountered in the facilities of small or large tv stations. For example, it may be necessary to monitor a video signal that does not contain sync pulses, such as the output of an iconoscope film chain to which sync is added at the master control point.

In addition, rapid pushbutton switching of the signal input, such as may be encountered in preview operation, requires that the tv monitor accept and function rapidly with a minimum of operator control to measure input signals with a wide range of characteristics.

Input signals from which the monitor must be capable of operating include composite video, video and blanking only (without sync) and remote or network signals with degraded sync.

Automatic Sync

In monitoring a composite video signal, it is desirable to use the sync pulse contained therein for synchronizing the monitor sweep circuits, as in a home receiver operating from an off-the-air signal. However, to monitor a signal that does not contain sync information, such as a signal originating at an iconoscope film chain, synchronization at the monitor must be provided by driving pulses from the sync generator, which trigger the deflection circuits.

An electronic switching circuit shown in Fig. 1 selects the mode of synchronization automatically.

In the absence of sync on the input video signal, a pulse-width discriminator circuit functions to gate in cutoff bias on the sync control tube and to permit driving pulses to continue synchronization of the monitor deflection circuits. When sync pulses are present in the video signal, the driving pulses, although available, are blocked. When it is desired to synchronize on driving pulses regardless of the character of the input video signal, a manual switch effectively immobilizes the automatic circuit by applying cutoff bias to the grids of appropriate sections of the sync selector stages.

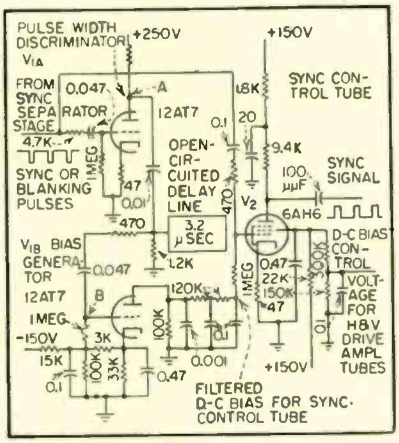

PULSE WIDTH DISCRIMINATOR
V_{1A}
+250V
+150V
FROM SYNC SEPARATOR STAGE
0.047
A
12AT7
1.8K
SYNC CONTROL TUBE
0.1
20
4.7K
OPEN-CIRCUITED DELAY LINE
9.4K
1MEG
SYNC OR BLANKING PULSES
47
0.01
470
100 μμF
SYNC SIGNAL
V_2
6AH6
470
3.2 μSEC
D-C BIAS CONTROL
V_{1B} BIAS GENERATOR
1.2K
0.047
12AT7
B
0.47
22K
150K
300K
1MEG
120K
VOLTAGE FOR H&V DRIVE AMPL TUBES
1MEG
47
-150V
3K
100K
0.1
15K
100K
33K
0.001
0.1
0.47
+150V
FILTERED D-C BIAS FOR SYNC CONTROL TUBE

FIG. 1—Automatic sync selector circuit takes composite or camera signals

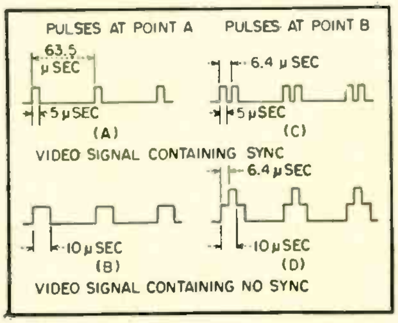

PULSES AT POINT A
PULSES AT POINT B
63.5 μSEC
5 μSEC
(A)
6.4 μSEC
5 μSEC
(C)
VIDEO SIGNAL CONTAINING SYNC
6.4 μSEC
10 μSEC
(B)
10 μSEC
(D)
VIDEO SIGNAL CONTAINING NO SYNC

FIG. 2—Waveforms encountered at points *A* and *B* in circuit of Fig. 1

As shown in Fig. 1, the video signal has been passed through a sync separator tube, which clips the tops of the pulse peaks in its grid circuit. When the video signal contains sync, the pulses appearing in the plate of the sync separator stage will have the same width as the sync pulses from which they are derived, approximately 5 microseconds (Fig. 2A). When the video signal contains no sync, the pulses appearing in the plate of the sync separator stage will have the same width as the blanking pulses from which they are derived, approximately 10 microseconds (Fig. 2B). Clipping here takes place in the setup region.

Delay Technique

These pulses are fed to the grid of the pulse width discriminator V_{1A}, which contains a delay line of 3.2 μsec in its plate circuit; the sending end is properly terminated while the receiving end is open-circuited. Pulses arriving at point *A* in Fig. 1 add directly to their echoes that have been delayed 6.4

μsec by virtue of travel to and reflection from the open-circuited receiving end of the delay line.

Resulting waveforms occurring at point *B* are shown in Fig. 2C for a signal with sync pulses and for a signal without sync pulses in Fig. 2D.

For a narrow 5-microsecond pulse, the reflection appears as a similar pulse delayed 6.4 μsec behind the original. This pulse train, when applied to the grid of bias generator tube, V_{1B}, a grounded plate-negative cathode stage normally biased below cutoff, is of insufficient amplitude to cause plate-current conduction.

Under this condition, the d-c output of the bias generator, which is coupled directly to the control grid of the sync control tube V_2, is substantially zero or ground potential. Thus, sync signals present at this point are amplified by the sync control tube and passed to the deflection synchronizing circuits.

In the case of the wider 10-μsec blanking pulse, the reflected pulse is superimposed upon the initiating pulse as shown in Fig. 2D. The resultant pulse train, with almost twice the peak-to-peak amplitude of that developed by the narrow pulses, causes V_{1B} to conduct and lower its plate voltage. Under this condition, the filtered d-c output of the bias generator is sufficiently negative (about 18 volts) to bias the sync control tube beyond cutoff and prevent the passage of sync information through it to the deflection synchronizing circuits.

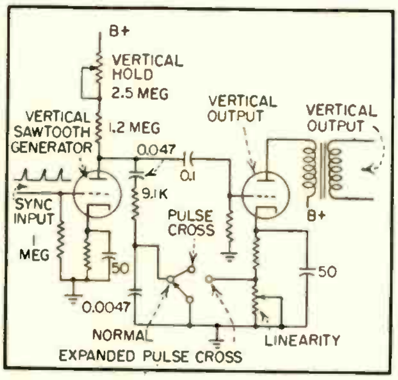

B+
VERTICAL HOLD 2.5 MEG
VERTICAL SAWTOOTH GENERATOR
1.2 MEG
0.047
0.1
VERTICAL OUTPUT
VERTICAL OUTPUT
SYNC INPUT
9.1K
PULSE CROSS
B+
1 MEG
50
50
0.0047
NORMAL
LINEARITY
EXPANDED PULSE CROSS

FIG. 3—Pulse cross display circuit

Thus, in the presence of sync pulses on the video signal, the sync control tube passes this sync information, while for a signal without sync pulses, this tube is biased beyond cutoff. In the latter case, it is now necessary to gate in driving pulses to the sync circuits to maintain synchronization.

Generator Sync

Gating action is controlled by sync control tube V_2 through its shift in d-c screen potential under the two conditions of control grid bias. With substantially zero bias when sync is present in the video signal V_2 conducts fully, causing the screen voltage to drop by virtue of the *IR* drop in the screen resistor. This drop is coupled to the control grids of the horizontal and vertical drive amplifier tubes, causing them to be biased beyond cutoff and preventing drive pulses from being passed to the deflection synchronizing circuits.

When there is no sync in the video signal, the sync control tube is biased beyond cutoff, raising its screen potential to the static voltage divider value. The higher screen potential applied to control grids of the drive amplifier tubes causes them to conduct and pass the amplified drive signals to the deflection synchronizing circuits.

A unique feature of the monitor is its ability to check accurately the timing waveforms of the sync generator by means of pulse-cross presentations. Periodic observation and adjustment of the sync generator pulse output is necessary in any tv station. The monitor pulse-cross display permits these measurements to be made accurately and at a moment's notice.

A three-position switch permits selection of normal, pulse-cross and expanded pulse-cross presentations. The regular pulse-cross presentation displays the entire blanking region, both horizontal and vertical.

Pulse-Cross Displays

The expanded pulse cross presentation enlarges the vertical blanking interval about five times, permitting critical and accurate examination of the timing in this region. The relative timing and shape of the front porch, back porch, sync pulse, equalizer pulse, vertical serration, number of equalizer pulses, number of vertical serrations—all these can be readily determined from this display.

In the pulse-cross position, the start of the horizontal sweep is delayed by approximately 66 percent in relation to the horizontal sync pulse in the video signal to permit the observation of all vertical equalizer pulses as well as the horizontal blanking interval. The start of the vertical sweep is delayed by approx-

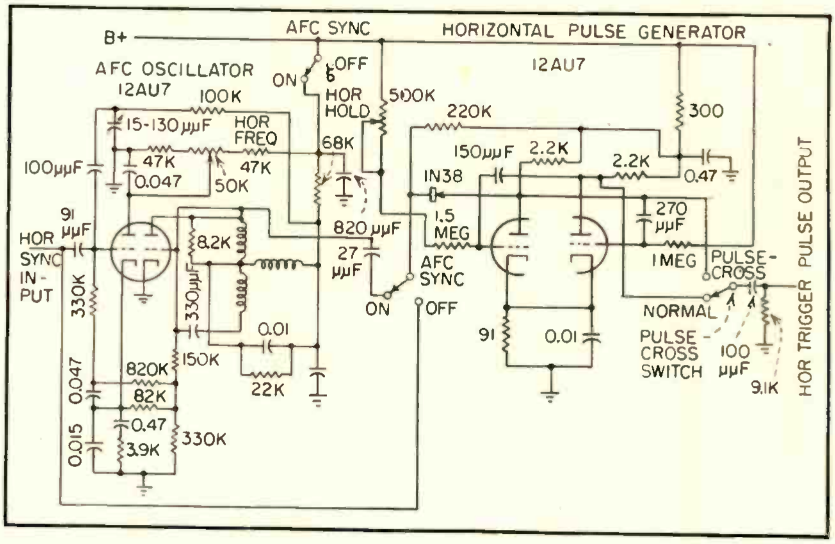
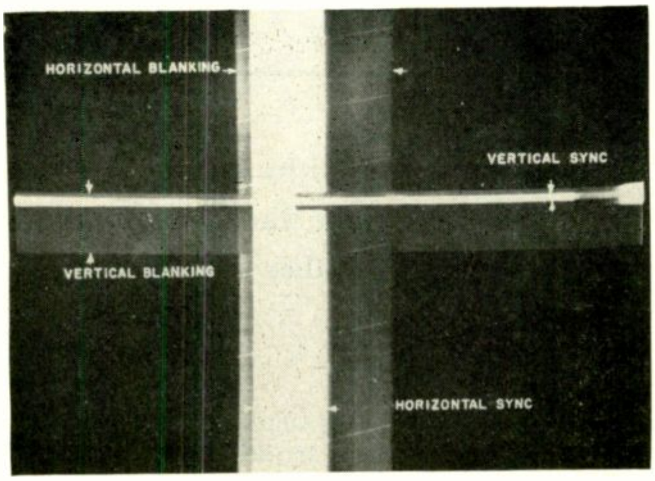
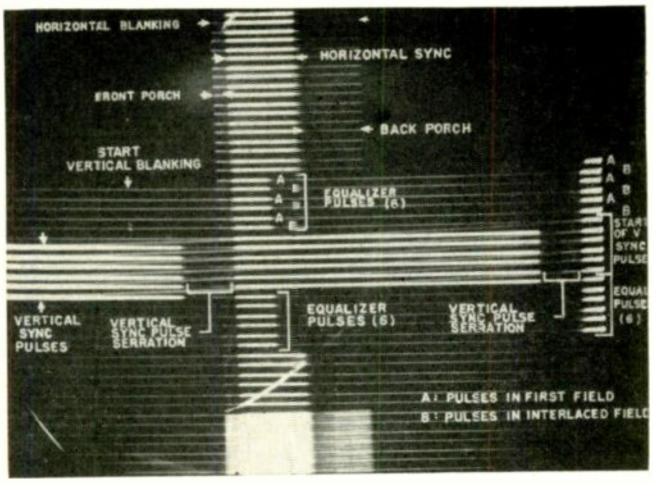

B+
AFC SYNC
HORIZONTAL PULSE GENERATOR
AFC OSCILLATOR
12AU7
ON
OFF
12AU7
100K
HOR HOLD
500K
220K
300
15-130 μμF
HOR FREQ
68K
150 μμF
2.2K
2.2K
100 μμF
47K
47K
IN38
0.47
0.047
50K
91 μμF
1.5 MEG
270 μμF
HOR SYNC IN-PUT
8.2K
820 μμF
27 μμF
AFC SYNC
1 MEG
PULSE-CROSS
330K
330 μμF
ON
OFF
NORMAL
0.01
91
0.01
PULSE-CROSS SWITCH
100 μμF
150K
820K
22K
9.1K
0.047
82K
0.47
0.015
3.9K
330K
HOR TRIGGER PULSE OUTPUT

FIG. 4—Flywheel sync control similar to that used in television receivers


HORIZONTAL BLANKING
VERTICAL SYNC
VERTICAL BLANKING
HORIZONTAL SYNC

Pulse cross display resulting from delayed sync and inverted picture polarity


HORIZONTAL BLANKING
HORIZONTAL SYNC
FRONT PORCH
BACK PORCH
START VERTICAL BLANKING
A
B
EQUALIZER PULSES (6)
START OF V SYNC PULSE
VERTICAL SYNC PULSES
VERTICAL SYNC PULSE SERRATION
EQUALIZER PULSES (6)
VERTICAL SYNC PULSE SERRATION
EQUAL PULSE (6)
A: PULSES IN FIRST FIELD
B: PULSES IN INTERLACED FIELD

Expanded pulse cross permits counting significant pulses from sync generator

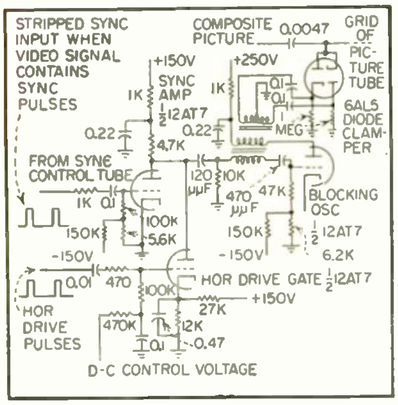

STRIPPED SYNC INPUT WHEN VIDEO SIGNAL CONTAINS SYNC PULSES
COMPOSITE PICTURE
0.0047
GRID OF PICTURE TUBE
+150V
+250V
SYNC AMP ½12AT7
1K
1K
0.1
0.1
6AL5 DIODE CLAMPER
0.22
0.22
1 MEG
4.7K
FROM SYNC CONTROL TUBE
120 μμF
10K
1K
0.1
470 μμF
47K
BLOCKING OSC
150K
100K
5.6K
150K
½12AT7
-150V
-150V
6.2K
0.01
470
100K
HOR DRIVE GATE ½12AT7
+150V
27K
HOR DRIVE PULSES
470K
12K
0.1
0.47
D-C CONTROL VOLTAGE

FIG. 5—Back-porch clamping circuit allows switching between composite and camera signals without adjusting black level

imately 50 percent in relation to the vertical sync pulse in the video signal. These delays are achieved by the use of horizontal and vertical multivibrator circuits running synchronously. In order that details in the blanking intervals may be observed with good contrast, the video signal on the grid of the picture tube is inverted. Thus, white represents sync top level, gray represents pedestal level and black represents white level.

Expanded Blanking

Expansion of the vertical blanking interval is accomplished by the circuit shown in Fig. 3. In the expand position, the charging capacitance in the plate circuit of the vertical sawtooth generator is effectively reduced by the addition of a small series capacitor that increases the slope of the generated sawtooth approximately five times. At the same time, the bias of the vertical output stage is reduced by shorting out some of the cathode resistance in order to center the display on the central and linear portion of the vertical scanning cycle.

Flywheel Sync

Greater synchronization stability in the presence of noisy or degraded sync, such as may be present in a remote signal under marginal conditions, is assured by a horizontal flywheel sync circuit. The circuit, which can be switched in, is a modified version of the synchro-guide arrangement widely used in tv receivers. It is shown in Fig. 4.

Black level fixed reference is maintained over wide variations in video signal content and level by line-to-line back-porch clamping. This eliminates the need for frequent adjustment of the brightness control, otherwise necessary with a conventional d-c restorer circuit. Back-porch clamping is ideal in monitor operations where many different video signals may be sampled in rapid succession.

For instance, in going from a composite video signal that contains sync information to a signal containing video and blanking only, the d-c restorer, which restores on sync pulse tips in the one case and to the pedestal level in the other, would give a shift in black level of approximately 30 percent. The back-porch clamper keeps black level fixed for the two signals.

Back-Porch Clamp

The clamp drive pulses are derived from either the trailing edge of the separated sync pulses or the trailing edge of the horizontal drive pulses, depending only on whether or not sync pulses are present in the video input signal. The circuit needs no adjustment and operates automatically for all types of input signals, the only requirement being that the pulse width of horizontal drive be less than the pulse width of horizontal blanking by at least 2 microseconds for satisfactory pedestal clamping of a video signal without sync pulses.

The clamper circuit of Fig. 5 consists of a dual diode driven from the low-impedance center-tapped winding on a blocking oscillator transformer.

The clamp drive pulses, of approximately 2 microseconds width, trigger the blocking oscillator, which operates as a slave circuit normally biased to cutoff.

Trigger pulses are obtained by differentiation and amplification of either sync or horizontal drive pulses as described above. Separate amplifiers gate in either of the two different trigger sources, depending on the bias conditions at the sync control tube.

Four-Channel FSK

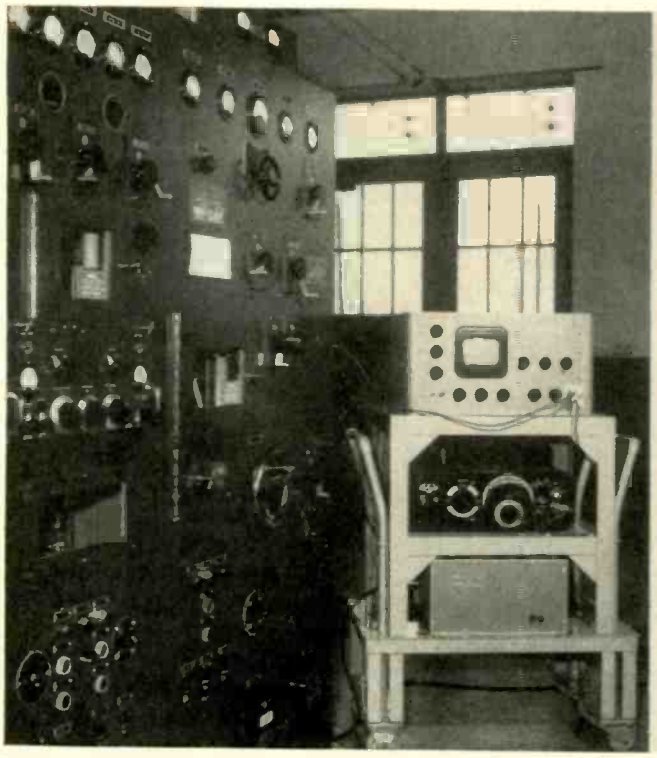
New frequency-shift keyer adapts any class-C radiotelegraph transmitter to multichannel operation. Overall frequency spread of only 3.85 kc provides four channels including keying sidebands. Transmitter driver uses heterodyne system rather than frequency multiplication to select assigned carriers from 4 to 24 mc

FREQUENCY-SHIFT generation of a new form described below allows multiple frequency-shift channels from a single radio transmitter while at the same time permitting an exciter of reduced size and cost. This development was carried out primarily to obtain additional channels by use of two or more frequency-shifted carriers passing through a single linear amplifier. The new type of frequency-shift excitation resulting can be applied to any class-C telegraph transmitter for ordinary single-channel working. The embodiment of the new generation and multichanneling scheme has been given the name Polyplex.

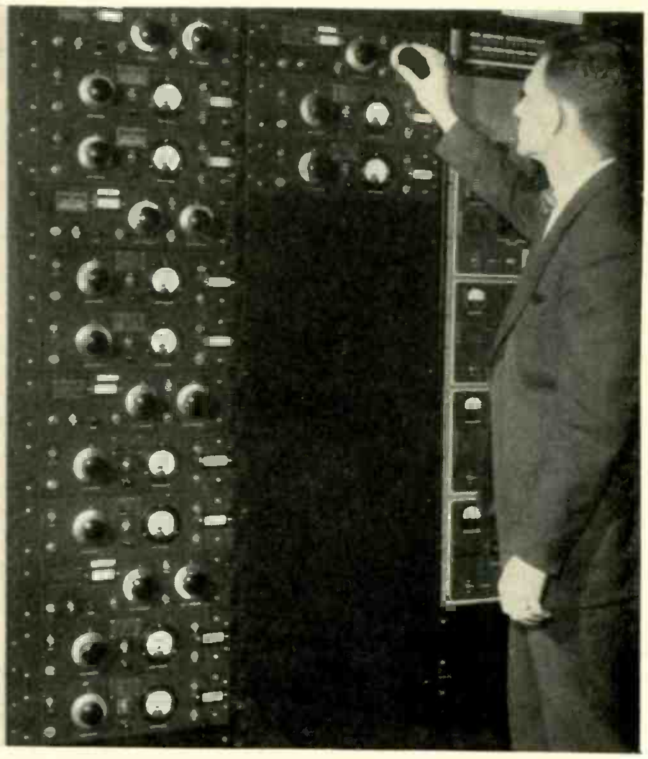
In the Polyplex system delineated in Fig. 1 all component circuits have been reduced to the essentials necessary for maximum stability and overall effectiveness in radiotelegraphy. In effect this system is a composite of single-sideband as well as frequency-shift techniques. Fundamentally, these two methods are the same. Frequency-shift keying is the telegraphic counterpart of single-sideband suppressed-carrier as applied to telephony. At present, four frequency-shifted channels are derived from the system, using standard radiotelegraph transmitters of 7.5-kw and 30-kw class-C rating in which the final and penultimate amplifiers have been converted to linear operation. Terminal equipment associated with these transmitters to produce four channels is less expensive than that formerly required for single-channel frequency-shift keying.

Exciter Unit

Generation of the frequency-shifted carriers is accomplished in exciter units of the type shown in Fig. 2. Carrier shift is obtained by means of reactance-tube frequency-modulation of a 200-kc oscillator of the series-tuned *LC* type. The modulating and oscillating func-



Driver stage is mounted in transmitter (left). Panoramic distortion-measuring equipment on dolly can be wheeled to required location



Group of five exciters (two dials) and combining units (two for each exciter) provides four channels on each of five transmitters

Adds Radio Circuits

By CHRISTOPHER BUFF

Project Engineer
Mackay Radio and Telegraph Co.
International Tel. & Tel. Corp.
New York, N. Y.

tions for each carrier are combined in one tube, a type 6SN7. Considerable effort was expended in obtaining a very pure 200-kc waveform so that two or more oscillators could be combined without producing intermodulation distortion. As a result, total harmonic distortion in each oscillator is less than 1 percent.

A high degree of frequency stability without temperature-controlled ovens is required. The present design shows a maximum drift of about ten cycles for a temperature variation from 20 to 50 deg C over a 24-hour period. Compensating capacitors are employed to offset frequency variations owing to temperature. However, no attempt is made completely to neutralize this effect because this leads to jumpiness in oscillator frequency and nonuniformity in production.

By using a heterodyning process to obtain final output frequencies in the 4 to 26-mc range, rather than the usual frequency multiplication, total drift on 26 mc is essentially the same as on 200 kc, plus the small drift of the associated high-frequency crystals.

Each 200-kc reactance-tube oscillator section is followed by its own class-A triode amplifier and then coupled into a common tuned-plate circuit, which is transformed to a 70-ohm output impedance for feeding a coaxial line to the transmitter at a level of 1 to 2 volts. This source actuates the driver chassis located in the radio transmitter.

The Twinplex[1] method of keying, which permits two channels from each of the two carriers produced by one exciter, is used to obtain a total of four channels. A combiner circuit is shown in Fig. 3. Bandwidth permitting, it is possible to parallel two exciter outputs on the coaxial line for a total of eight channels.

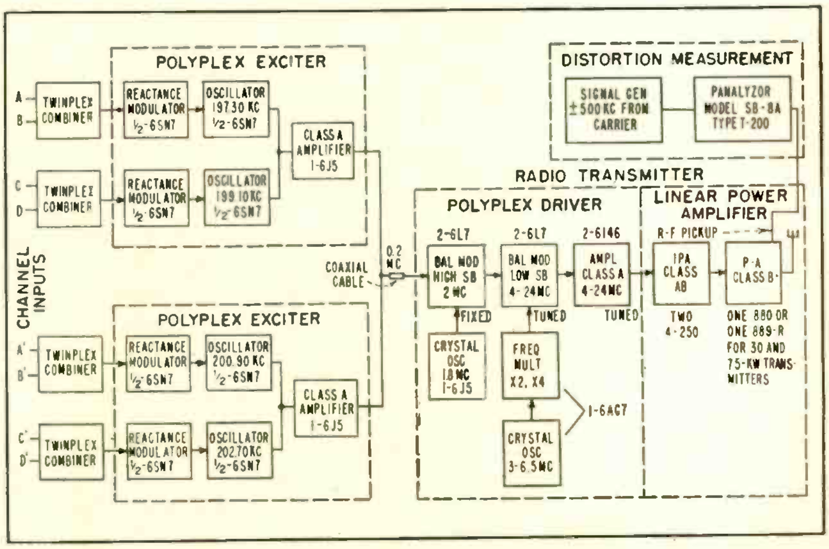

POLYPLEX EXCITER
A
B
TWINPLEX COMBINER
REACTANCE MODULATOR ½-6SN7
OSCILLATOR 197.30 KC ½-6SN7
C
D
TWINPLEX COMBINER
REACTANCE MODULATOR ½-6SN7
OSCILLATOR 199.10 KC ½-6SN7
CLASS A AMPLIFIER 1-6J5
CHANNEL INPUTS
POLYPLEX EXCITER
A'
B'
TWINPLEX COMBINER
REACTANCE MODULATOR ½-6SN7
OSCILLATOR 200.90 KC ½-6SN7
C'
D'
TWINPLEX COMBINER
REACTANCE MODULATOR ½-6SN7
OSCILLATOR 202.70 KC ½-6SN7
CLASS A AMPLIFIER 1-6J5
COAXIAL CABLE
0.2 MC
DISTORTION MEASUREMENT
SIGNAL GEN ±500 KC FROM CARRIER
PANALYZOR MODEL SB-8A TYPE T-200
RADIO TRANSMITTER
POLYPLEX DRIVER
2-6L7
BAL MOD HIGH SB 2 MC
2-6L7
BAL MOD LOW SB 4-24 MC
2-6146
AMPL CLASS A 4-24 MC
FIXED
TUNED
TUNED
CRYSTAL OSC 1.8 MC 1-6J5
FREQ MULT X2, X4
CRYSTAL OSC 3-6.5 MC
1-6AC7
LINEAR POWER AMPLIFIER
R-F PICKUP
IPA CLASS AB
TWO 4-250
P-A CLASS B
ONE 880 OR ONE 889-R FOR 30 AND 75-KW TRANSMITTERS

FIG. 1—Block diagram shows interconnections for four-channel Polyplex system used commercially. Eight channels shown can be used if bandwidth permits

Figure 4 shows the frequency spectrum for four-channel operation. Using Twinplex keying on each carrier, effective power is doubled over that existing for conventional mark-space keying of separate channels because for the same number of channels the available transmitter power is spread over only half the number of carriers.

For making the equivalent of the two-tone test to check overall transmitter distortion, both oscillators of this exciter are placed on mark-mark condition and this produces two equal-level carriers at the output, 2,150 cycles apart.

Transmitter Driver

As in other types of radiotelegraph transmitters in which crystal oscillator, buffer, keying stage and frequency multipliers are mounted on a single chassis, the Polyplex driver is similarly assembled. The basic driver comprises two bal-

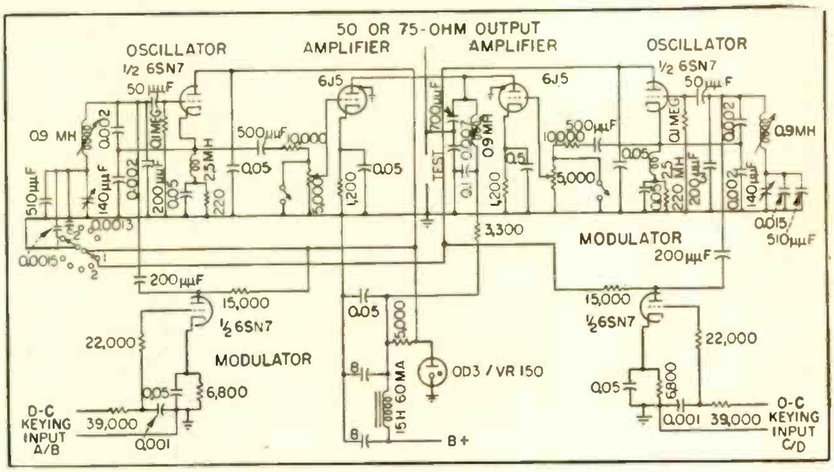
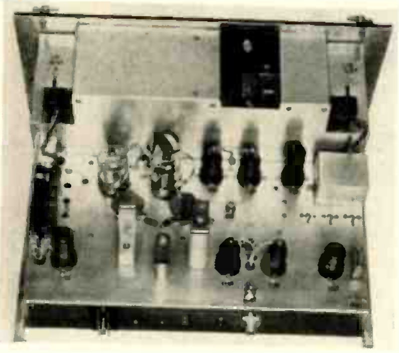

50 OR 75-OHM OUTPUT
OSCILLATOR
½ 6SN7
50 μμF
0.9 MH
0.002
0.1 MEG
510 μμF
140 μμF
0.002
200 μμF
0.05
2.5 MH
220
0.0013
0.0015
AMPLIFIER
6J5
500 μμF
10,000
0.05
5,000
1,200
0.05
TEST
700 μμF
0.1
0.0007
0.9 MH
AMPLIFIER
6J5
1,200
0.5
500 μμF
10,000
5,000
OSCILLATOR
½ 6SN7
50 μμF
0.1 MEG
0.002
0.9 MH
0.05
2.5
220
200 μμF
0.002
140 μμF
0.015
510 μμF
3,300
MODULATOR
200 μμF
200 μμF
15,000
½ 6SN7
22,000
MODULATOR
0.05
6,800
D-C KEYING INPUT A/B
39,000
0.001
0.05
5,000
8
8
15H 60 MA
OD3 / VR 150
B+
15,000
½ 6SN7
22,000
0.05
6,800
0.001
39,000
D-C KEYING INPUT C/D

FIG. 2—Exciter combines four inputs to driver



Driver stage transposes 200-kc keying frequencies into range from 4 to 26 mc

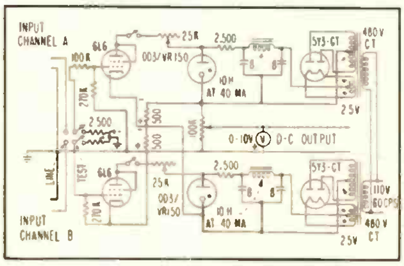

INPUT CHANNEL A
6L6
100K
25K
2,500
OD3/VR150
10H AT 40 MA
5Y3-GT
480V CT
270K
25V
500
100K
0-10V
V
D-C OUTPUT
LINE
TEST
INPUT CHANNEL B
110V 60CPS

FIG. 3—Twinplex combiner feeds two signals to exciter (Fig. 2)

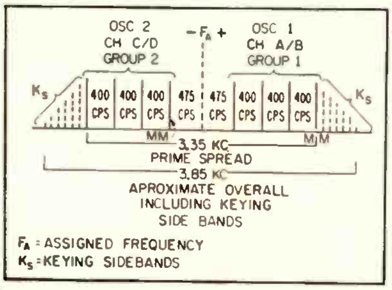

OSC 2
CH C/D
GROUP 2
−F$_A$+
OSC 1
CH A/B
GROUP 1
K$_S$
400 CPS
475 CPS
MM
M M
3.35 KC
PRIME SPREAD
3.85 KC
APROXIMATE OVERALL INCLUDING KEYING SIDE BANDS
F$_A$ = ASSIGNED FREQUENCY
K$_S$ = KEYING SIDEBANDS

FIG. 4—Four-channel frequency spectrum

anced modulators, two crystal oscillators and a linear push-pull output amplifier suitable for driving the type 4-250 penultimate stage of the transmitter. These features are shown in Fig. 5. The first balanced modulator is fixed tuned at 2 mc which is the high-frequency sideband resulting from the mixing of an associated 1,800-kc crystal oscillator and the 200-kc signals coming in on the coaxial line from the exciter.

The 2-mc output is fed in push-pull to the grids of a second balanced modulator that may be switched and tuned over the range from 4 to 24 mc. The low-frequency sideband is chosen throughout this range as the final output frequency. This sideband results from the 2-mc signals mixing with harmonics of a high-frequency crystal oscillator operating on a fundamental range of 3 to 6.5 mc and always utilizing either the second or fourth harmonic of the crystal. A feature of this circuit is the use of double-tuned highly selective circuits in the crystal multiplier output.

This precaution results in at least 50-db attenuation of all but the desired second or fourth harmonic to which the circuit is tuned. A small peaking trimmer is used on the second tuned circuit to permit optimum selectivity throughout the range. The extra tuned circuit eliminates the need for using various odd harmonics of the crystal to prevent spurious outputs from the second balanced modulator. For example, if 14-mc output is desired it should be the resultant of the fourth harmonic of 4-mc minus 2-mc. However, if adequate multiplier selectivity is not provided, 14-mc may also be produced by the third harmonic of 4-mc plus 2-mc. Both 14-mc frequencies would be radiated, one spurious.

Neutralizing Voltage

Following the second balanced modulator is a push-pull linear amplifier utilizing type 6146 tetrodes operating class A. Output from one side is capacitively coupled to the parallel 4-250 stage in the transmitter, which is operated class AB. Output from the other side provides a 180-degree out-of-phase neutralizing voltage for the 4-250's.

In the design of the driver rapid frequency change is provided without introducing distortion. All biases and driver levels are preset to the best possible compromise between distortion and output over the entire range from 4 to 24 mc. A single drive-level control on this unit, which is in the 200-kc input circuit from the coaxial line, serves to adjust the operating output level of the complete transmitter.

The maximum distortion products during a two-tone test are 35-db or more below the main signal at the output of the 6146 stage for a drive level sufficient to operate the transmitter to at least 17-kw peak power output. The transmitter final output shows the distortion 28 to 30 db down.

In the driver all facilities associated with other types of radiotelegraph operation have been incorporated. It is possible to operate on-off keying, with class B or C operation of the transmitter, through the same unit. Likewise, straight frequency-shift with class-C operation may be used. When two carriers are required to provide

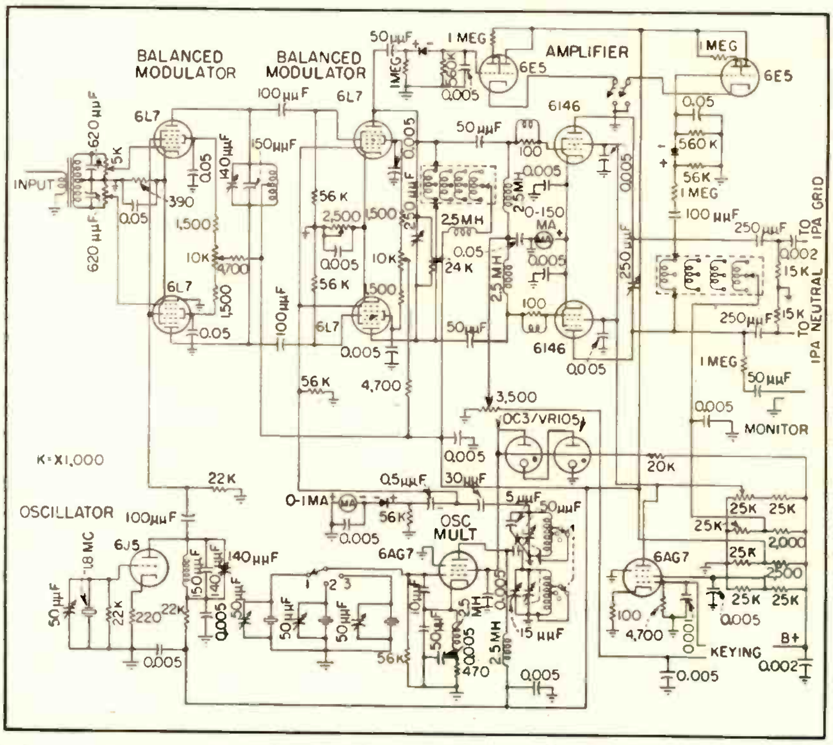

BALANCED MODULATOR
BALANCED MODULATOR
AMPLIFIER
INPUT
6L7
6L7
6L7
6L7
6E5
6E5
6146
6146
620 μμF
15K
390
0.05
140 μμF
150 μμF
1,500
10K
4700
100 μμF
56 K
2,500
0.005
1 MEG
560K
50 μμF
2.5MH
0-150 MA
24 K
250 μμF
3,500
OC3/VR105
4,700
K=X1,000
OSCILLATOR
6J5
1.8 MC
22K
220
0-1MA
OSC MULT
6AG7
6AG7
2.5 MH
470
15 μμF
20K
25K
2,000
MONITOR
KEYING
B+
TO IPA GRID
TO IPA NEUTRAL

FIG. 5—Driver assembly takes four-channel input and keys transmitter

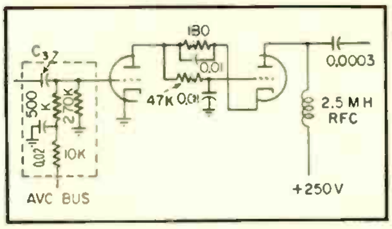


FIG. 6—Cascode stage improves receiver r-f

additional channels, the drive level to the transmitter is reduced by means of a front-panel control until linear operation results in all stages of the transmitter.

Distortion products under linear operation are observed on a panoramic type presentation so that results are immediately evident. This feature permits rapid tuneup and changeover from class-C to linear operation. The driver characteristics are also suitable for single-sideband telephony when associated with suitable voice frequency terminal equipment.

Receiving Equipment

Multichannel reception is carried out on a dual-diversity basis. For four-channel operation two identical receiver bays are used, one for channels A/B and one for channels C/D. Each pair of radio receivers is controlled by an external high-frequency crystal or variable-frequency oscillator of high stability tuned specifically to receive one of the two pairs of channels. By using separate high-frequency oscillators tuned in this manner, the same audio frequencies result from each pair of receiver outputs and this in turn allows identical filters to be used in the frequency-shift conversion equipment following. This conversion equipment is the same as that previously used for Twinplex operation employing filter center frequencies of 1,950, 2,350, 2,750 and 3,150 cycles.

Radio receivers are Hammarlund SP-400 and SP-600 types especially modified for optimum performance on fsk telegraph operation. In one model the 6K7 first r-f stage has been replaced with a 12AT7 in a cascode circuit (Fig. 6) for improved signal-to-noise ratio over the whole 4 to 26-mc range. Above 20 mc a 10-db improvement over the original circuit is obtained as shown in Fig. 7.

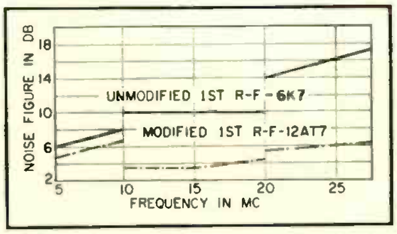


FIG. 7—Improvement in signal-noise for receiver using cascode r-f

The antenna input is converted to 50-ohm impedance for unbalanced coaxial cable. A broad-band 4 to 26-mc balanced-to-unbalanced transformer couples the low-impedance coaxial line to the antenna feedpoint. These transformers are made for various balanced input impedances such as 1,000, 500, 200, 100 and 50 ohms. The output impedance is 50 ohms unbalanced in each case and the transformer loss is held to within 1-db over the 4 to 26-mc range.

The Polyplex system is closely akin to single-sideband working and precautions must be taken in the receiver as well as in the transmitter to minimize nonlinearity and consequent intermodulation in all stages. The distortion is carefully checked with two-frequency input varied over a wide range of levels—about 60 db—as would normally be encountered in high-frequency propagation. It was found, in the SP-400 receiver, that the main factors in achieving a low value of distortion are the application of the proper amount of avc and cathode bias on the 12AT7 first r-f stage and the injection of a sufficiently strong intermediate oscillator signal at the plate of the third i-f stage.

In the original receiver there was also considerable overdrive, with strong signals, of the third i-f stage, which caused blocking of the second detector and mutilation of the signals. This condition was remedied by changing the third i-f tube from a 6SK7 to a 6SJ7 with considerably reduced plate and screen voltages.

The intermediate-frequency oscillator or bfo acts as the reinserted carrier and for best results it should be at least 10-db above the signal level at the point of mixing. The rather simple expedient of using a 1.8-millihenry peaking coil in series with the bfo signal line to the third i-f mixing point proved effective in raising the injected 467.5-kc bfo voltage from 10 to 50 volts, or about 14-db. This voltage gain is realized through an impedance transformation.

If the local carrier oscillator is not much stronger than the signal the detector output will contain distortion products of importance in the form of difference frequencies between the two or more signal carriers present. When these difference frequency components fall within the desired signaling bands, mutilation of the signals usually results.

When a Polyplex signal is picked up on a communications receiver in which the aforementioned design principles have not been properly applied, spurious frequencies on either side of the main signal may be noticed in the receiver output. The spurious effect will increase as the r-f or, in some cases, the i-f gain is increased. With multichannel operation, as in single-sideband working, the receiver must be given consideration equal to that afforded the transmitter with respect to effects of distortion and intermodulation, especially at maximum gain settings. These are points often overlooked in the design of standard communications receivers.

System Operation

The present Polyplex system was based on the use of existing Twinplex filtering and conversion equipment to reduce obsolescence. Development of a new receiver-converter designed specifically for the system will allow transmitted bandwidth to be cut in half. Further development also continues in the transmitter proper towards greatly increased power output under linear operation with the same number of stages.

The Mackay radio circuit between New York and Tangier has been operated on a Polyplex basis for more than a year. A four-channel multiplex may be operated on each of these four Polyplex channels in the future.

REFERENCE

(1) C. Buff, Twinplex and Twinmode Radiotelegraph Systems, *Electrical Communication*, p 20, Mar. 1952.

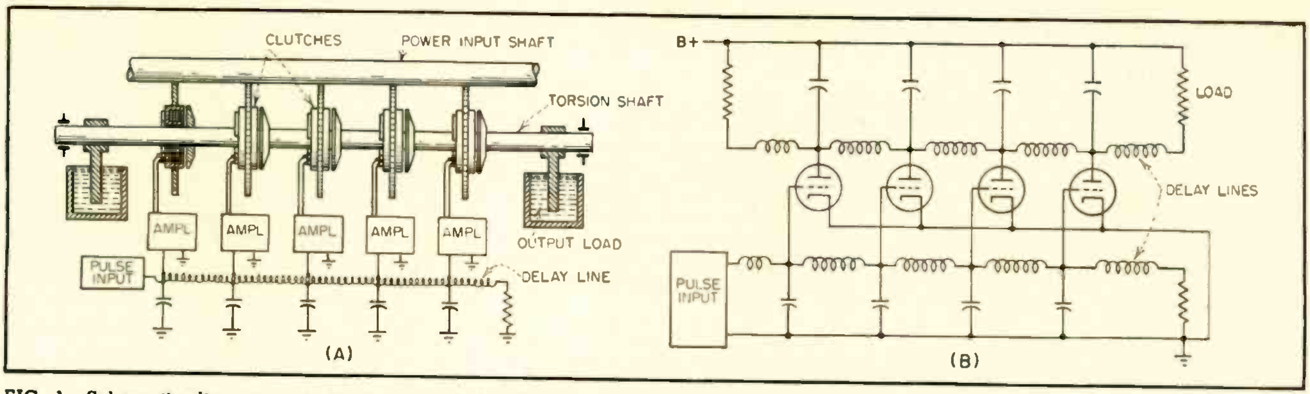


FIG. 1—Schematic diagrams of clutch-actuated distributed transducer (A) and analogous distributed amplifier (B)

Distributed Transducer

Nonresonant magnetostrictive device sets up high-energy traveling waves at ultrasonic frequencies. Possible applications include study of elastic properties of materials, frequency-modulated sonar and ultrasonic cutting tools

TRAVELING WAVES of ultrasonic energy can be set up in a long magnetostrictive rod by a distributed amplifier similar to those used in wide-band r-f service.

The distributed amplifier consists of eight stages of amplification bridged between an input delay line and a distributed plate load—excitation coils spaced along the magnetostrictive rod.

The distributed ultrasonic transducer was developed as the result of an investigation of magnetic-fluid clutches which entailed a search for a satisfactory method for employing magnetic clutches in the transmission of large amounts of power at cycling speeds in the ultrasonic range.

A small magnetic clutch could be built to operate at ultrasonic speeds but a large one would not behave as a rigid body and the transmission of large amounts of power would not be ordinarily possible.

A solution to the problem was suggested by the distributed electronic amplifier. In such an amplifier a large amount of power can be handled by several low-power stages ganged by delay lines so that their inputs and outputs are in parallel without their input and output impedances shunting.

If a mechanical analog of the electronic distributed amplifier could be built, it would have considerable advantages for generation of mechanical oscillations of high amplitudes. Figure 1A illustrates such a distributed mechanical transducer. Several small magnetic clutches actuated by a distributed amplifier are arranged to produce torsional oscillation of high frequency and high power. For comparison, Fig. 1B shows a typical distributed amplifier in which electrical power is transferred to a load by traveling-wave action.

Magnetostrictive Transducer

To study the principles involved in the distributed magnetic clutch, a distributed amplifier was devised to set up traveling waves of ultrasonic energy in a magnetostrictive rod. The resulting lengthening and shortening of the rod could then be changed back into electrical energy, and fidelity and efficiency of electromechanical energy conversion studied. Other means for producing traveling ultrasonic waves such as piezoelectric crystals could also have been employed.

The first model of the magnetostrictive transducer utilized thyratrons to pulse the excitation coils. Fixed time delays were inserted between the thyratrons to delay the input signal by the correct amount. Interstage delays were each individually adjustable and made equal to the transit time of the elastic wave traveling down the output rod.

The basic operation of a distributed amplifier can be understood with reference to Fig. 1B. Pulses are fed into the output by each stage and travel in both directions. Pulses traveling toward the left are absorbed in the resistor shown to prevent reflections and resulting interference.

For the same reason, a frictional termination must be supplied for the free end of the magnetostrictive rod. In practice, however, it has proved difficult to devise such a termination since there is apparently no simple way in which mechanical vibration can be totally, or nearly totally, absorbed.

Final Circuit

The device shown in Fig. 2 is an improved version of the magnetostrictive transducer. In this model, push-pull 6L6's are used to pulse the output line and the input elec-

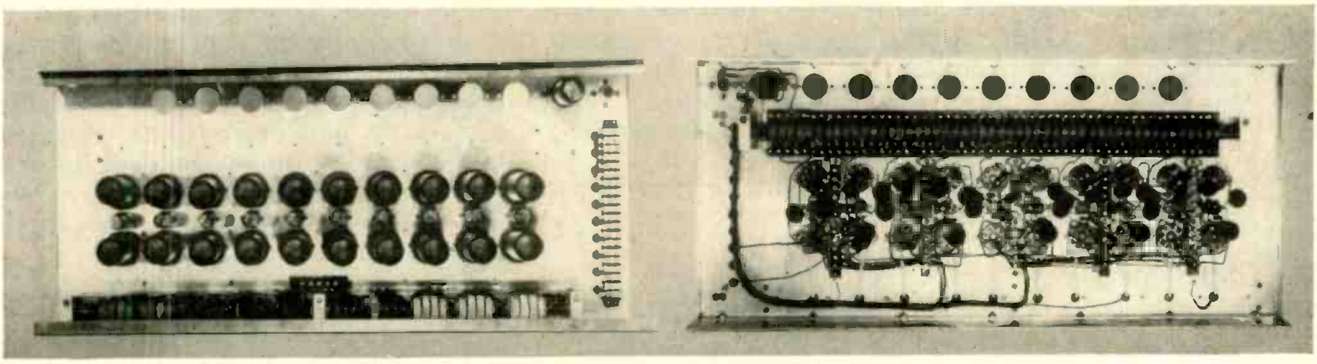


FIG. 2.—Above (left) and below (right) chassis views of f-m magnetostrictive transducer showing exciting coils and delay line

for Ultrasonic Power

By **JACOB RABINOW*** and **MAURICE APSTEIN**

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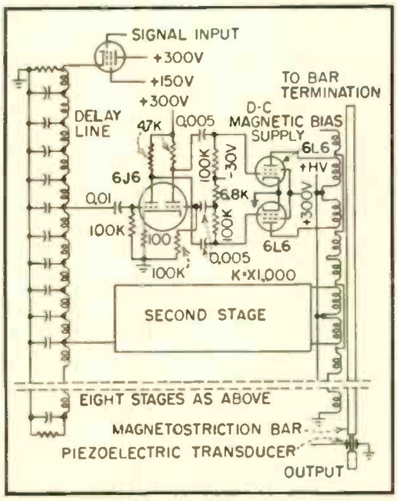

FIG. 3—Magnetostriction amplifier showing delay lines

trical delay line is so constructed that its propagation velocity matches that of the output bar. To measure the output of the transducer, a piezoelectric crystal is attached to the output end of the rod. A circuit diagram of a typical amplifier stage is shown in Fig. 3.

In the final tests, the piezoelectric transducer was replaced by a mutual-inductance r-f transducer developed at NBS.[1] This transducer measures displacement of the end of the bar without coming in contact with it and is believed to give a more correct indication of the bar's motion. Considerable effort was spent on the development of a suitable termination for the unused end of the bar. Best results were obtained by the friction termination shown in Fig. 4. It consists of small permanent magnets placed against the bar and a cylindrical weight clamped to the end of the bar as shown. By adjusting the clamping force, reflections from this end of the bar can be kept to a sufficiently low value.

The great advantage of a distributed transducer is that it is inherently not a resonant device. Because the oscillations in the output member are excited in a space-distributed system, the mechanical length of the bar has no effect on the frequency of oscillation. This should be contrasted with an oscillating system where the physical constants of the system determine the period of oscillation so that the buildup of amplitude is created by successive impulses arriving in time phase with the natural oscillation of such a system. Another inherent and very great advantage of a distributed network is that the heat dissipation and, therefore, the energy that can be delivered to the

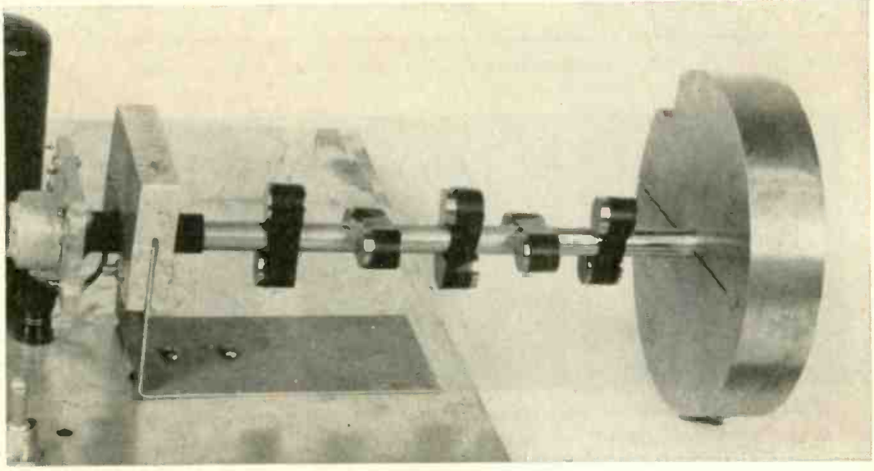
FIG. 4—Termination for end of output bar. Alnico magnets taped to bar in conjunction with clamped weight act as friction device to reduce reflections

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* Formerly Technical Advisor, Diamond Ordnance Fuze Laboratories.

device is much greater than that of an equivalent resonant device operated at the same frequency, because the dimensions of the former can be so much greater.

To test the wide-band characteristics of the transducer, a frequency-modulated oscillator was built to feed the input electrical delay line and a special output-detector network was designed to measure the output. The circuit diagrams of these devices are shown in Fig. 5 and 6. With these two units coupled to the magnetostrictive transducer, voice frequencies were transmitted over the network. Overall performance is shown in Fig. 7.

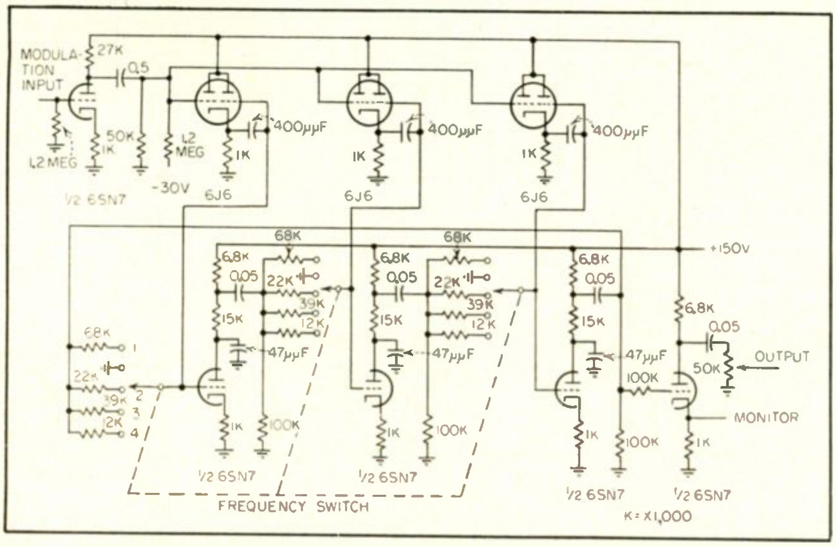
MODULATION INPUT
27K
0.5
1.2 MEG
50K
1K
1.2 MEG
-30V
1/2 6SN7
6J6
400μμF
1K
6J6
6J6
68K
6.8K
0.05
22K
39K
12K
15K
47μμF
100K
1
2
3
4
+150V
0.05
50K
OUTPUT
MONITOR
1/2 6SN7
FREQUENCY SWITCH
K=X1,000

FIG. 5—Frequency-modulated oscillator for transducer. Frequencies for positions 1, 2, 3 and 4 of the frequency switch are 10.4, 20, 13 and 27 kc respectively

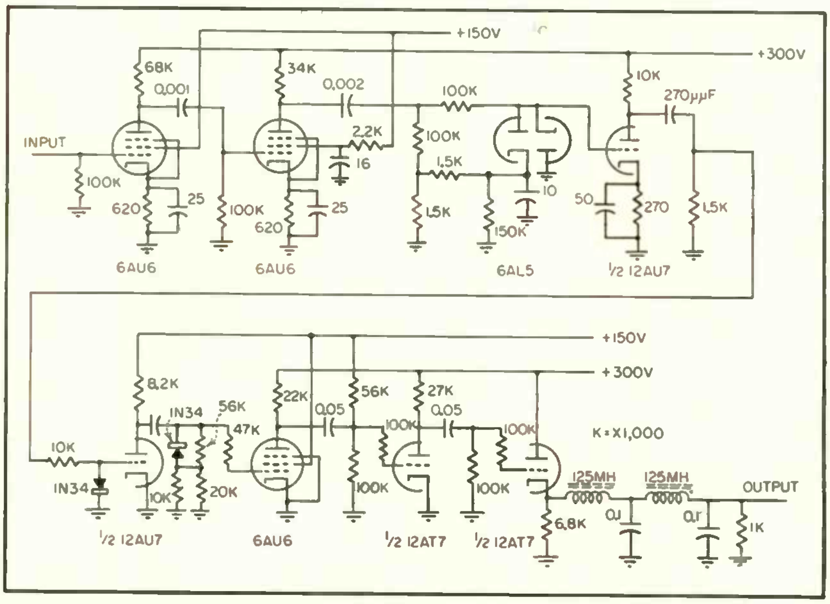
+150V
+300V
68K
0.001
INPUT
100K
620
25
6AU6
34K
0.002
2.2K
16
100K
620
25
6AU6
100K
1.5K
10
150K
6AL5
10K
270μμF
50
270
1.5K
1/2 12AU7
+150V
+300V
8.2K
IN34
56K
47K
10K
IN34
10K
20K
1/2 12AU7
22K
0.05
56K
6AU6
27K
0.05
100K
100K
1/2 12AT7
100K
100K
1/2 12AT7
K=X1,000
125MH
125MH
6.8K
0.1
0.1
1K
OUTPUT

FIG. 6—Low-frequency discriminator used to measure transducer output

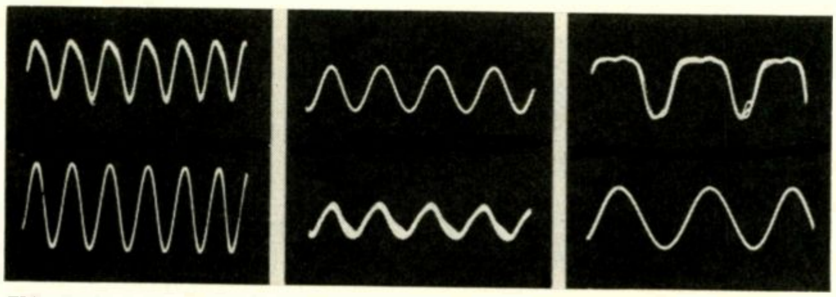

FIG. 7—Frequency-modulated signals transmitted by magnetostrictive transducer. Top row of waveforms are inputs from f-m oscillator modulator. Bottom row of waveforms are outputs from discriminator. The frequencies from left to right are 500, 1,000 and 1,500 cps. An f-m carrier frequency of 27 kc with a maximum frequency deviation of ±15 percent was used

In later work, tests were made to compare the relative effectiveness of rods and tubes. Because of skin effects at high frequencies, magnetostriction takes place only near the surface of the transducer. Tubes with wall thicknesses of $\frac{1}{16}$ inch showed an increase in output as compared to rods. Thinner tubes should show still higher efficiencies.

Applications

High-energy ultrasonic vibrations are now being employed in the drilling of ceramics, glass and other hard materials. The broadband characteristics of such transducers may have wide applications in military applications of ultrasonics. The ability to maintain a high-energy traveling wave through long lengths of material is of importance to the study of physical properties of the materials. The stress-strain relationships obtained with steady application of forces do not hold for pulses of short duration. The rate at which pulses travel through a physical body is one of the clues to the elastic properties of the body and it has been difficult in the past to obtain pulses of high energy traveling for appreciable distances through test specimens. The ability to produce longitudinal or torsional oscillations of very large amplitude should also prove useful in the testing of materials, both in fatigue testing of the materials themselves and in inducing vibrations in devices attached to the transducers.

The author thanks Ernest Codier who designed and built the two models of the distributed transducer and electronic equipment, Herbert Curchack who developed the friction termination and did much of the experimental and theoretical work and Israel Rotkin for his supervision and advice.

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R. V. L. Hartley, Acoustic Distributed Transmission System, U. S. Patent Office, No. 1,629,100, May 17, 1927.

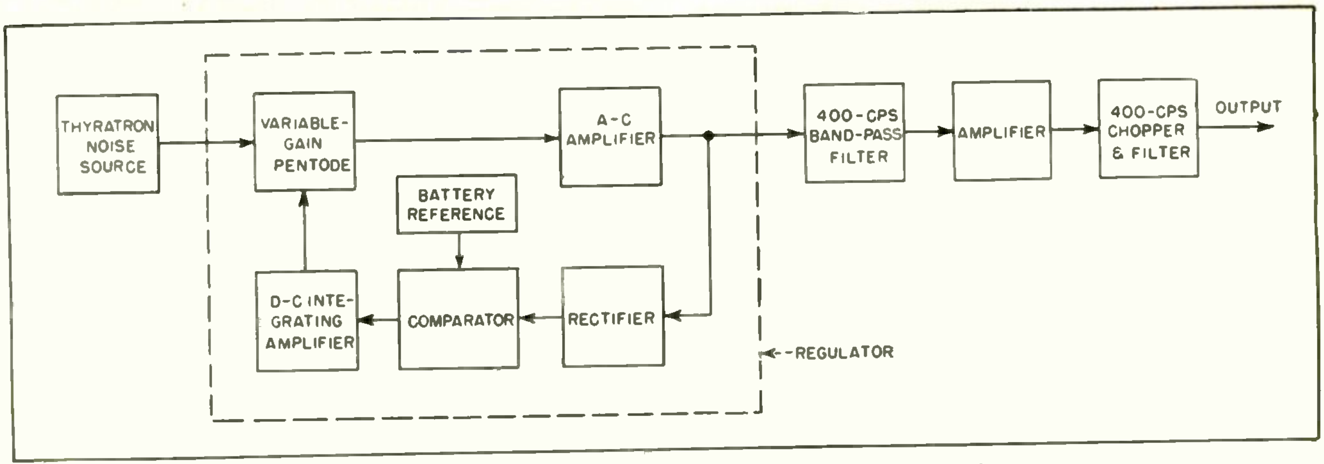
THYRATRON NOISE SOURCE
VARIABLE-GAIN PENTODE
A-C AMPLIFIER
BATTERY REFERENCE
D-C INTEGRATING AMPLIFIER
COMPARATOR
RECTIFIER
REGULATOR
400-CPS BAND-PASS FILTER
AMPLIFIER
400-CPS CHOPPER & FILTER
OUTPUT

FIG. 1—Block diagram of complete noise generator with voltage regulator portion shown in detail

Stabilized Noise Source for Air-Weapons Design

Signal simulates radar noise, air turbulence and circuit noise for design of air weapons by electronic analog. Output of thyratron noise source is voltage regulated and filtered to provide uniform noise signal from 0 to 35 cps

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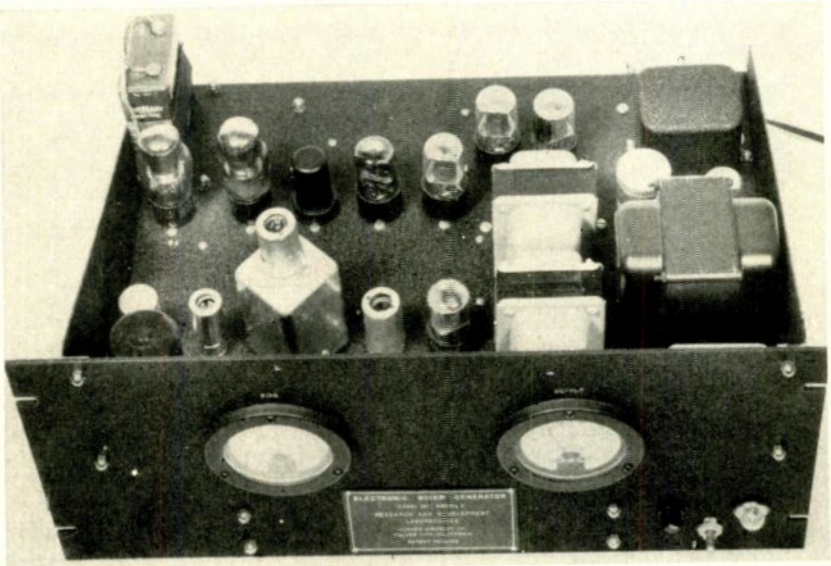
RECENT YEARS have seen striking advances in the design of guided missiles and other aerial weapons systems. With these advances has come an increasing awareness of the importance of noise and other statistical considerations in modern complex aerial guidance and control systems. Faced with the fact that the noise is, due to the nature of its origin, almost fundamentally unavoidable the system designer is forced to build his system to live with the noise and yet give optimum performance.

Noise Generator

In the design and analysis of complex systems, simulation has come to be a key tool. It has become possible, furthermore, to inject or simulate the various random quantities appropriate to such studies. Radar noise, air turbulence, manufacturing irregularities and circuit noise



Layout of stabilized noise generator illustrates how shield cans are utilized to avoid spurious pickup are examples of statistical inputs that may be electronically generated and supplied to simulation equipment. This article describes a noise generator that can be used with electronic analog computers as the basic source of noise and other random quantities. It is a precision device designed to provide for accurate, quantitative system simulation.

The frequency spectrum of the noise generator output is uniform from d-c to 35 cps, which more than covers the range useful for most simulator applications. Thus it produces white noise for frequencies below 35 cps.

The probability distribution of the output voltage amplitude is Gaussian or normal,[1] which is the desired distribution for most uses. Other distributions can be obtained through the use of auxiliary apparatus.

A block diagram of the noise generator is given in Fig. 1. The primary source of noise is a type 5727 thyratron. The output level of the noise from the gas tube varies with heater voltage and envelope temperature and in addition appears to vary due to changes in cathode emission. Since these variations are at low frequencies it is possible to use a regulator to compensate for them. The bandwidth of noise accepted by the regulator must be sufficiently wide to permit averaging of the noise level and yet allow for a reasonably short time constant for the regulating action. The noise supplied to the regulator extends from about 30 cps to 3 kc.

Regulator

The regulator circuit is indicated on the block diagram. The noise is passed through a variable-gain pentode, amplified and half-wave rectified. The rectified noise is compared with a reference battery and the difference averaged by the integrator circuit. This is equivalent to first averaging the rectified noise and then comparing this average with the battery reference.

If the average noise amplitude is greater than the battery voltage the gain of the variable-gain pentode is reduced. If the noise is less, the gain is raised. Thus the output of the regulator is noise whose average amplitude is constant and whose spectrum extends from 30 cps to 3 kc.

Due to the nature of the gas tube the amplitude probability distribution at this point is nearly Gaussian. Some distortion is introduced by the slightly nonlinear character of the variable-gain pentode.

A complete schematic of the regulator appears in Fig. 2. The meter indicates the bias on the type 5749

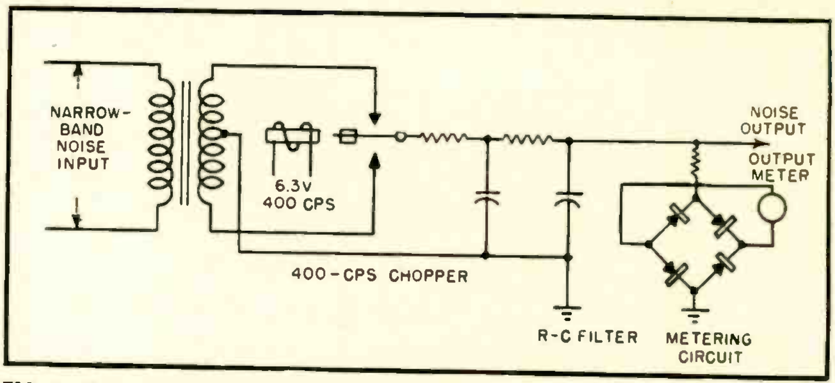

NARROW-BAND NOISE INPUT
6.3V 400 CPS
400-CPS CHOPPER
NOISE OUTPUT
OUTPUT METER
R-C FILTER
METERING CIRCUIT

FIG. 4—Output circuit includes chopper, R-C filter and metering circuit

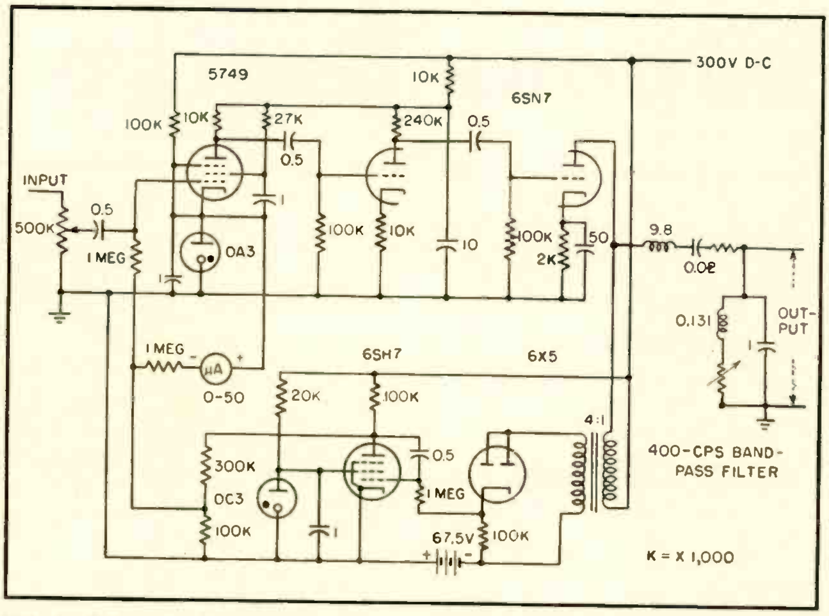

INPUT
500K
0.5
1 MEG
5749
100K
10K
27K
0.5
1
0A3
1
10K
240K
100K
10K
10
0.5
6SN7
100K
2K
50
300V D-C
9.8
0.02
0.131
1
OUT-PUT
1 MEG
μA
0-50
6SH7
6X5
20K
100K
300K
0C3
100K
1
0.5
1 MEG
67.5V
100K
4:1
400-CPS BAND-PASS FILTER
K = X 1,000

FIG. 2—Schematic diagram of voltage regulator circuit with 400-cps band-pass filter in its output

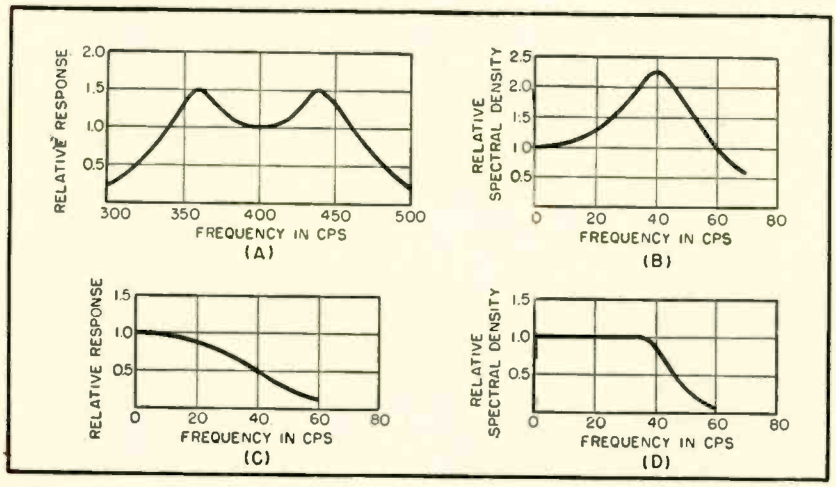


FIG. 3—Frequency response of filters and resulting spectral density of noise signal illustrate development of uniform spectrum

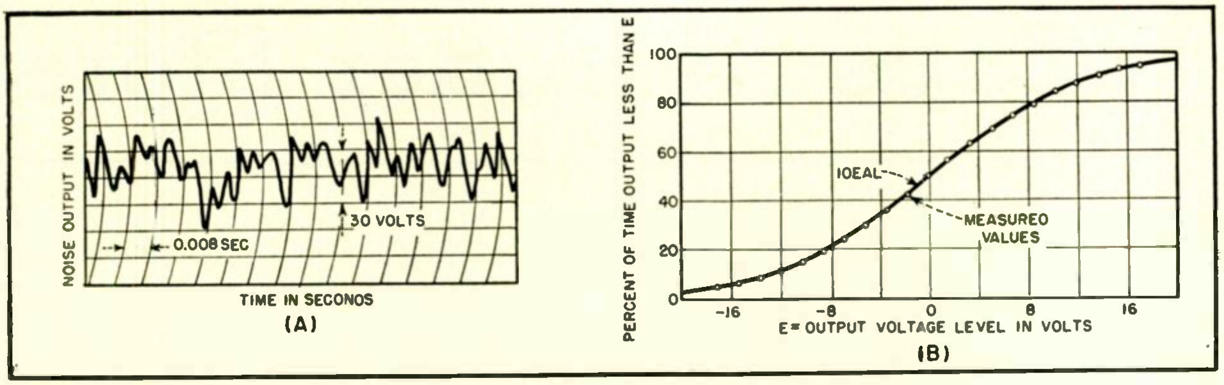


FIG. 5—Recorder sample of noise generator output (A) and probability distribution showing agreement between measured and theoretical values (B)

variable-gain pentode and is a measure of the noise level at the input to the regulator. This indication allows adjustment of the noise input level such that the regulator will operate in the proper region. This adjustment however, is not critical and ordinarily requires no attention.

The spectral density of the regulator output is uniform in the center of the 30-cps to 3-kc band. A portion of this spectrum is selected by the filter whose transmission characteristic is given in Fig. 3A. Thus the output of the filter is centered at 400 cps and has a bandwidth of approximately 100 cps. A degree of adjustment of the frequency response shown is afforded by the variable resistances in the filter circuit. Stabilized toroids and capacitors are used.

Noise Detection

After amplification by a feedback amplifier the noise is detected by a standard 400-cps electromechanical chopper, Fig. 4. The chopper multiplies the noise voltage alternately by plus one and minus one. This multiplication by a square wave results in frequency components consisting of sums and differences of the noise frequencies and the chopper frequency and its various harmonics.

Thus there is low-frequency noise (a component at either 395 cps or 405 cps in the amplifier output will yield a 5-cps noise component at the chopper output) and noise centered at 800 cps, 1,200 cps, 1,600 cps etc. For a perfectly symmetrical chopper only the odd harmonics of 400 cps would be present. The R-C filter which follows the chopper effectively eliminates the high-freqency components, leaving the low-frequency noise.

If there were no R-C filter the spectrum of the low-frequency portion of the output would be as shown in Fig. 3B. The R-C filter, whose gain is shown in Fig. 3C, modifies the spectrum of Fig. 3B to give the output spectrum shown in Fig. 3D. Thus the doubly peaked gain characteristic shown in Fig. 3A was chosen for the filter at the output of the regulator.

The two filters compensate such that the resulting output spectrum is essentially uniform or flat. Measurements show that this arrangement gives a spectrum flat within 0.1 db from d-c to 35 cps.

The frequency shifting procedure insures a uniform spectrum at frequencies less than 1 cps which is not commonly obtainable due to power-supply noise at these low frequencies.

In addition the noise spectrum falls off rapidly above 40 cps. This is a desirable feature inasmuch as the useful dynamic range of the output is not decreased by the presence of useless high-frequency components.

Electronic means can be used for the detection process. However, the electromechanical chopper has the advantage that it does not introduce any d-c offset in the output. This is often an important factor in simulation work.

A standard panel meter is filled with heavy silicone fluid to give a mechanical time constant of several minutes. Such heavy smoothing is needed to average the output voltage since the frequencies involved are so low. Since the noise amplitude is stabilized by a regulator, the output meter serves merely as a monitoring device during operation.

The portion of a strip chart reproduced in Fig. 5A constitutes a typical recorded sample of the noise generator output. The amplitude distribution at the regulator output is not perfectly Gaussian. However, since the noise bandwidth at this point is many times wider than the bandwidth of the filter the amplitude distribution at the output of this filter is insignificantly different from Gaussian. The final output of the noise generator is Gaussian, therefore, since the circuit is linear following this filter.

System Performance

Accurate measurements have been made of the output amplitude distribution. A result of such a measurement, showing the cumulative probability distribution, is given in Fig. 5B. This curve extends to a voltage level that is twice the standard deviation of the output (approximately 10 volts). However, measurements show that the distribution is accurately normal to values in excess of four times the standard deviation, which is more than sufficient for almost all simulation work. The differences between the actual measured values and the ideal curve are within the experimental error.

Reasonable precautions are exercised in construction to insure that any 400-cps fields do not induce voltages in the low-level circuits, since such signals would result in a d-c offset in the output. An interleaved shield can is placed over the chopper for this reason.

Reference

(1) James, Nichols and Phillips, "Theory of Servomechanisms," McGraw-Hill Book Co., Inc., New York, 1947.

Tape Recorder Stores

High-speed, 409,200-character output of computer is used for feeding at slower rate a tape-punch unit or electric typewriter. System can be used for handling teletype messages or telemetering data for processing or storage

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ELECTRONIC computing machines now operate so fast that electric typewriters and other conventional data-printing devices cannot keep up with them.

The magnetic tape input-output equipment to be described is designed for use with a large-scale data-processing computer. It serves as a buffer between this high-speed computer and slow-speed printers.

The equipment consists of an output recorder, tape-to-punch reader and input reader, Fig. 1. The output recorder stores output data from the computer on magnetic tape. This tape can be transferred to the tape-to-punch reader which plays back the data to a punch or an electric typewriter. If further processing of the data is required, the output recorder tape can be transferred to the input reader, which reads the data back into the computer.

Recording Technique

Saturation-pulse recording of the magnetic tape is used in the output recorder. The d-c erase head located ahead of the recording-head assembly erases any previously recorded information and uniformly biases the tape to saturation of one polarity. Pulses are then recorded to saturation in the other polarity. Pulses are recorded in six 0.025-inch parallel tracks at a pulse density of 40 pulses per inch. Six tracks were chosen because the output from the computer is a parallel five-level binary code. The extra track is available for locating or control.

Pulse density of 40 pulses per inch was chosen to combat the effects of dropouts due to irregularities in the tape surface and to allow playback at the relatively low playback speeds of the tape-to-punch recorder. The low playback speed and surface irregularities on the tape impose a practical lower limit to the amount of energy which must be stored in each of the magnetized marks on the tape. The use of narrow tracks made it desirable to record longer marks on the tape to store sufficient energy for low-speed playback.

Using these parameters, one seven-inch reel of magnetic tape can store 576,000 six-level binary characters at a density of 960 bits per square inch, providing adequate storage for the entire load of information.

The recording speed of the output recorder is 15 inches per second or 600 six-level characters per second. This is determined by the maximum rate at which information can be taken continuously from the magnetic-drum memory of the computer. With an operational rate of 600 characters per second, the entire memory of the computer, 409,200 characters, can be completely transferred in approximately 15 minutes.

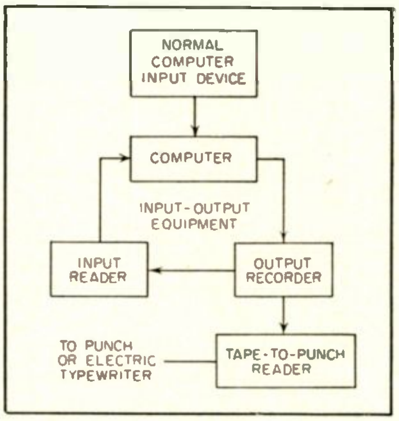


FIG. 1—Functional relationship of units of buffer storage medium

The input reader affords two playback speeds, 7.5 inches per second and 3.75 inches per second, 300 and 150 characters per second respectively. The tape-to-punch reader plays back at a tape speed up to 0.327 inch per second or 13.1 characters per second. The rate is determined by the output mechanism selected, punched paper tape or typewriter. This unit is under a-synchronous control of the output mechanism. It normally stops between characters on the tape until the mechanism receives a has-written signal, whereupon the tape starts moving again.

Tape-Handling Mechanisms

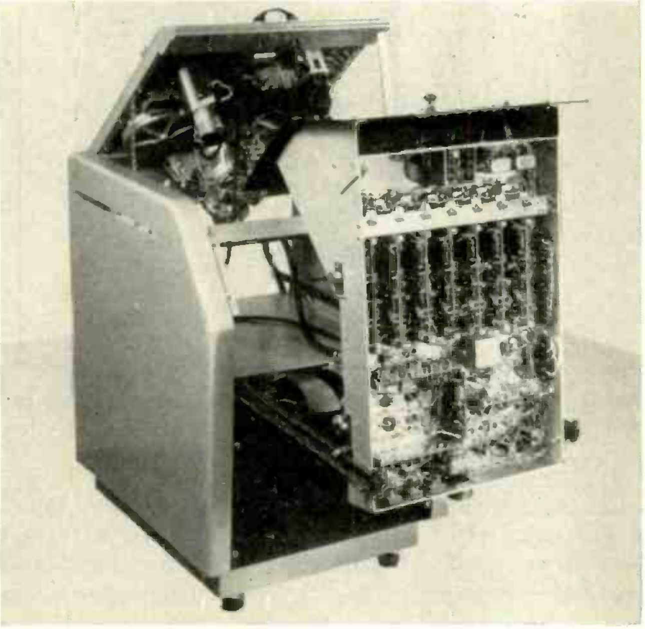
All three units use modified Ampex 400 series tape-handling mechanisms. The tape-handler for the output recorder was modified to allow normal operation or to be started and stopped. The capstan drive motor was removed from the tape-to-punch reader tape-handler and replaced with an electromechanical clutch allowing start and stop of the capstan to be controlled electrically. The capstan clutch was driven by a gear motor at a speed of 25 rpm to provide a tape speed of 0.327 inch per second. The idler flywheel was also removed and replaced with a driven wheel to provide faster acceleration of the tape.

Output Recorder

The output recorder is controlled by the computer. The tape is started

Computer Output

Output recorder and tape-to-punch reader shown from left-to-right. Pulses are recorded in six parallel tracks



Buffer storage unit in servicing position. All three units are similar in construction and appearance

in motion upon receipt of information from the computer, and the information is recorded as soon as the tape is up to speed. The tape continues in motion until no information pulses have been received for more than 0.25 second then stops until receipt of the next block of information.

After recording a character, the output recorder sends a has-written pulse back to the computer to request the next character. Recording rate of the output recorder is 600 characters per second. One character equals six information pulses in parallel.

Initiate-Write Pulse

Figure 2 is a block diagram of the output recorder. When power is first turned on, the buffer storage flip-flops and the gate flip-flop in the control section are set to the nonoperating position by the delayed ground return from the power supply. The first six information pulses are received, one at a time, from the computer. These pulses pass through the recirculation switch to the three-winding (one primary and two secondary) pulse transformers. When an information pulse is received in any channel an initiate-write pulse is sent from one secondary winding to the write gate where it is blocked. No writing can occur at this time. These information pulses trigger the buffer storage flip-flops through the other transformer winding.

Write Gate

When a buffer storage flip-flop is triggered, the thyratron gate writer in that channel is enabled, and the position line becomes positive. This positive condition is detected by the tape-drive detector. The tape drive flip-flop is triggered, and the tape drive starts. After a delay of approximately ¼ second produced by the gate delay, the write gate is enabled by the artificial initiate-write pulse which sets the gate flip-flop. This pulse also passes through the write delay to the write gate. Since the write gate is now open, the artificial initiate-write pulse is passed to the thyratron-gate writers as a write pulse. Each thyratron which has been enabled by an information pulse will fire, causing the corresponding head to record a pulse on the magnetic tape.

After the initial information character has been written, the gate-delay circuit does not function. Thus, as long as information continues to arrive from the computer, the position line will remain positive and the write gate will be enabled. The initiate-write pulses can pass through the write-delay circuit and write gate. The write-delay circuit produces a delay before each writing operation allowing the buffer storage flip-flops to set up and enable the thyratrons.

Has-Written Pulse

Each time a character is written, the buffer storage flip-flops are reset by a pulse from the thyratron writer, and the position line becomes negative. The has-written circuit detects this change and generates a delayed has-written pulse, which is sent to the computer. When the computer receives a has-written pulse, another information character is sent to the output recorder. When information no longer arrives, the position line becomes negative and the tape drive flip-flop is reset. This condition, after sufficient delay to allow for short gaps in the blocks of information, stops the tape drive and dis-

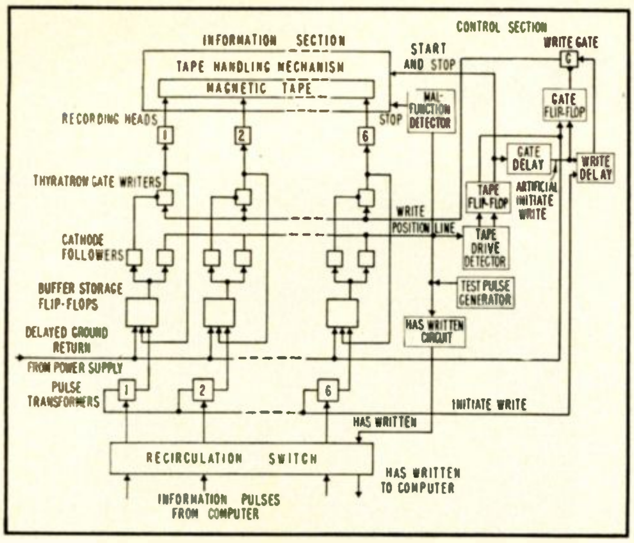

CONTROL SECTION
INFORMATION SECTION
WRITE GATE
START AND STOP
TAPE HANDLING MECHANISM
MAGNETIC TAPE
G
MAL-FUNCTION DETECTOR
GATE FLIP-FLOP
RECORDING HEADS
STOP
1
2
6
GATE DELAY
WRITE DELAY
THYRATRON GATE WRITERS
TAPE FLIP-FLOP
ARTIFICIAL INITIATE WRITE
WRITE POSITION LINE
CATHODE FOLLOWERS
TAPE DRIVE DETECTOR
TEST PULSE GENERATOR
BUFFER STORAGE FLIP-FLOPS
HAS WRITTEN CIRCUIT
DELAYED GROUND RETURN
FROM POWER SUPPLY
PULSE TRANSFORMERS
1
2
6
INITIATE WRITE
HAS WRITTEN
RECIRCULATION SWITCH
HAS WRITTEN TO COMPUTER
INFORMATION PULSES FROM COMPUTER

FIG. 2—Output recorder employs malfunction detector circuit to stop tape drive when recorder fails to operate properly

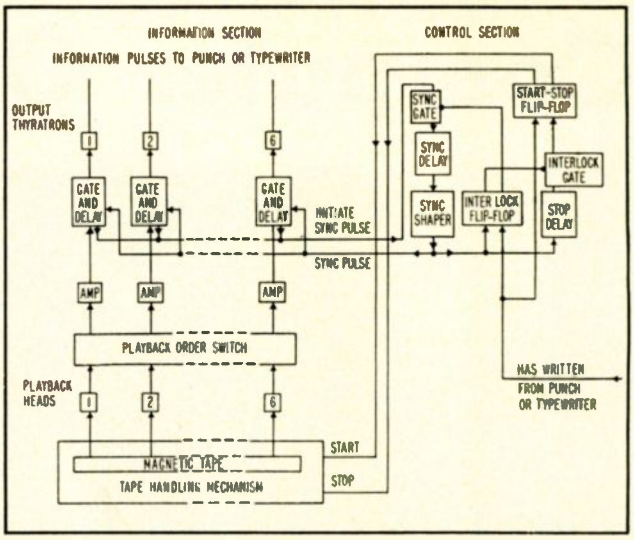

INFORMATION SECTION
CONTROL SECTION
INFORMATION PULSES TO PUNCH OR TYPEWRITER
OUTPUT THYRATRONS
1
2
6
SYNC GATE
START-STOP FLIP-FLOP
SYNC DELAY
INTERLOCK GATE
GATE AND DELAY
GATE AND DELAY
GATE AND DELAY
INITIATE SYNC PULSE
SYNC SHAPER
INTER LOCK FLIP-FLOP
STOP DELAY
SYNC PULSE
AMP
AMP
AMP
PLAYBACK ORDER SWITCH
HAS WRITTEN FROM PUNCH OR TYPEWRITER
PLAYBACK HEADS
1
2
6
START
MAGNETIC TAPE
TAPE HANDLING MECHANISM
STOP

FIG. 3—Tape-to-punch reader has interlock for continuous tape motion should output mechanism operate faster than reader

ables the recorder write gate.

The delay after receiving information and before writing, plus the delay introduced after writing and before transmitting the has-written pulse back to the computer, affords a means of controlling the recording rate. The initial delay in writing also resynchronizes the parallel pulses to insure parallel recording of the pulses on the six recording tracks.

The recirculation switch and test-pulse generator make up a testing circuit for testing the operation of the output recorder. If the recirculation switch is in operate position, information pulses pass through as described. If the switch is in single-pulse position, pulses originating in the test-pulse generator are passed through the switch to the information levels selected for testing. Test tape with pulses in any of the six levels may also be made in this manner.

A malfunction-detector circuit indicates when the output recorder is not operating properly. Any time the position line fails to receive a negative signal during a two-second period, the malfunction-detector circuit stops tape drive.

Tape-to-Punch Reader

The tape-to-punch reader shown in Fig. 3 reads information recorded by the output recorder and plays it back to a typewriter or paper-tape punch for recording.

The information pulses are read, one character at a time, from the magnetic tape by the playback heads. After a character has been read, the tape is stopped by the electromechanical capstan clutch until receipt of a has-written pulse from the punch or typewriter, whereupon the tape is started and the next character read. Thus the playback speed is determined by the punch or typewriter up to the maximum speed of 13.1 characters per second. An interlock is provided to allow continuous tape motion in event the output mechanism is capable of operating at higher speeds than the reader.

The playback-order switch determines the order in which information pulses are to be read, reversed or as recorded. This allows the tape to be played back without rewinding. These information pulses are amplified by plug-in preamplifiers and are transmitted to the gating and delay circuits. When the first information pulse of a character arrives at a gating and delay circuit, that circuit produces an initiate-sync pulse, which is sent to the control section. If the output mechanism has completed the preceding writing operation, it produces a has-written pulse, which sets the interlock flip-flop, and the sync gate is enabled, allowing an initiate-sync pulse to pass. This pulse is delayed, shaped, and transmitted back to the gating and delay circuits as a sync pulse. All of the information pulses temporarily stored in the gating and delay circuits are simultaneously sent to the typewriter translator adapter or to the tape punch when the sync pulse enables the gating and delay circuits.

Figure 4 illustrates the method of resynchronizing the pulses from the six levels by means of monostable-multivibrator gating circuits. The time constant of each multivibrator is slightly longer than half the period between pulses. The pulse from each of the playback heads triggers its multivibrator. Thus through using the initiate-sync pulse to form a sync pulse by delaying and re-shaping, the outputs from all six levels on the tape are resynchronized to allow for tape skew or slight head misalignment. This sync pulse also provides a means of obtaining a timing pulse without requiring a separate timing track to be recorded on the tape.

Multivibrator Gating Circuit

The gating circuit used for resynchronizing is shown in Fig. 5. The circuit consists of a cathode-coupled monostable multivibrator with a gating diode inserted in series with the plate load of the normally conducting side of the multivibrator. When triggered, normally cut-off V_{1A} conducts and V_{1B} is cut off for a period of time determined by R and C.

The positive-going pulse at the plate of V_{1B} is differentiated and triggers a sync delay and then a sync generator as shown by the waveforms of Fig. 4. The positive synchronizing pulse, thus generated when any one or more of the gating multivibrators has been triggered, is applied across the series diode through a series capacitor and resistor. If the multivibrator has been triggered the diode is not conducting and the pulse is capacitor coupled to the input of the thyratron stage. If the multivibrator has not been triggered, the pulse will be short-circuited by the current drawn through the multivibrator and the sync pulse will not be transmitted to the thyratron circuit.

The interlock flip-flop of Fig. 3 is set by the sync pulse, enabling the interlock gate and disabling the synchronizing gate to prevent generation of false synchronizing pulses.

The synchronizing pulse is also transmitted to the stop delay where it is delayed to allow time for completing the reading operation before stopping the tape.

If the output mechanism is capable of accepting information as fast as it is available from the tape, the interlock flip-flop, in conjunction with the has-written signal, provides a means of constant tape motion. If a has-written pulse is received before the tape is stopped, the interlock flip-flop is set to disable the interlock gate and block the stop signal to the electromagnetic clutch of the tape-handling mechanism and the tape continues in constant motion. If the output mechanism is not capable of accepting the information as fast as it is available from the tape the interlock gate will remain enabled. Then a stop signal from the stop-delay will be applied through the start-stop flip-flop to the tape handling mechanism.

The problem of providing enough amplification of the played-back signal from the tape was solved by utilizing plug-in preamplifiers designed to provide a gain of 8,000 in a single pentode stage at frequencies from 2 to 2,000 cps[1]. Heads were connected through a subsonic matching transformer to the input of the plug-in preamplifiers. Thus a signal of approximately 2 microvolts at the heads was stepped up 10 times by the transformer and 8,000 times by the preamplifiers to provide an output of over one volt by one stage of amplification.

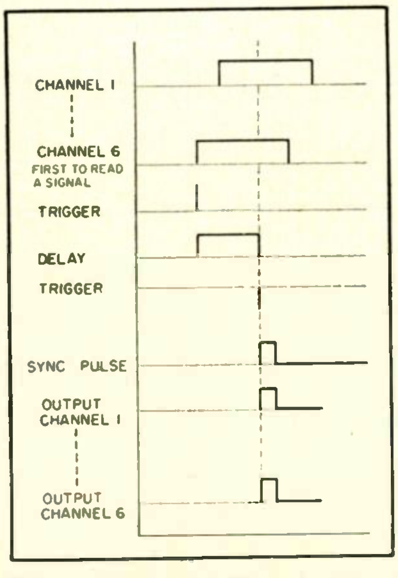


FIG. 4—Timing chart illustrates resynchronizing of pulses from six levels using monostable multivibrator gate

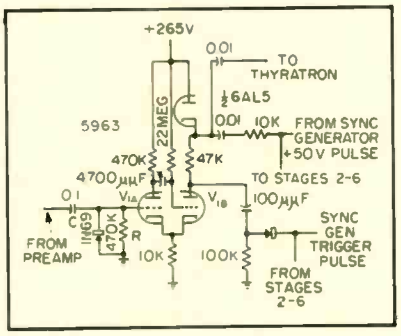


FIG. 5—Multivibrator gating circuit for resynchronizing played-back signals from magnetic tape

The input reader unit sends recorded information back to the computer. The playback-order switch determines which channel of the information section a pulse is to enter. These information pulses are then amplified and transmitted to the gating and delay circuits.

The first information pulse of a character to arrive at a gating and delay circuit produces a synchronized input pulse which is sent to the control section. This synchronizer input pulse is delayed, shaped, and transmitted back to the gating and delay circuits to synchronize the simultaneous insertion of a character into the computer. This circuit is similar to that of the tape-to-punch reader in operation.

The input-information pulses to the computer are 30 volt, 250 microsecond pulses. To provide a timing pulse, the synchronizer output also branches off in the control section and is delayed, shaped and sent to the computer with each character for synchronizing the input portion of the computer.

Test Results

Tapes recorded by the output recorder were used as input pulse sources for final testing of the tape-to-punch reader. A ten-to-one signal-to-noise ratio was observed at the output of the preamplifiers when the typewriter was not in operation.

With the typewriter in operation, the signal-to-noise ratio was approximately five-to-one. However, the circuits are normally disabled during typing thus minimizing the effect of interference. No trouble was experienced with typewriter operation when characters were typed out as recorded by the output recorder.

In the input reader signal-to-noise ratio at the output of the preamplifiers was found to be approximately twenty-to-one.

Final tests were conducted with the computer by recording data on the output recorder, re-entering the data into the computer, again recording it on the output recorder and finally typing out the information by means of the tape-to-punch reader. Satisfactory results were obtained.

Applications

Although the equipment was built for use with a specific computer, it might find many uses with other high-speed data processing systems or data transmission systems. For example, it may find application for storing radio-teletype messages sent at high speed for printing out at a later time. Telemetering data might also be recorded in a similar manner.

The equipment was developed for the Office of Naval Research at the suggestion of Engineering Research Associates Division of Remington Rand Inc.

The author wishes to express his thanks to the many persons who aided in the design and construction of this equipment, including H. L. Daniels, R. R. Ritter, B. F. Swezey and W. O. Edstrom.

REFERENCE

(1) H. L. Daniels, U. S. Patent No. 2,489,272.

Monochrome I-F Strip

Techniques for extending bandwidth of 3.5-mc monochrome receiver i-f strips to pass chrominance information. Outboard-mounting conversion unit described adapts i-f strip for color with a minimum of wiring changes

With the advent of 24 and 27-inch black and white picture tube sizes, more attention was paid by some designers to the better picture quality attainable by more fully utilizing the bandwidth capabilities of the transmitted signal by using wider bandwidth i-f amplifiers. A method will be shown of adapting a such monochrome i-f amplifier strip, flat to about 3.5 mc, for color television.

As shown in Fig. 1, the main difference between a 6-mc color channel and the corresponding monochrome channel is the addition of a chrominance subcarrier at 3.58 mc, with chrominance sidebands extending from approximately 2.3 mc to 4.2 mc.

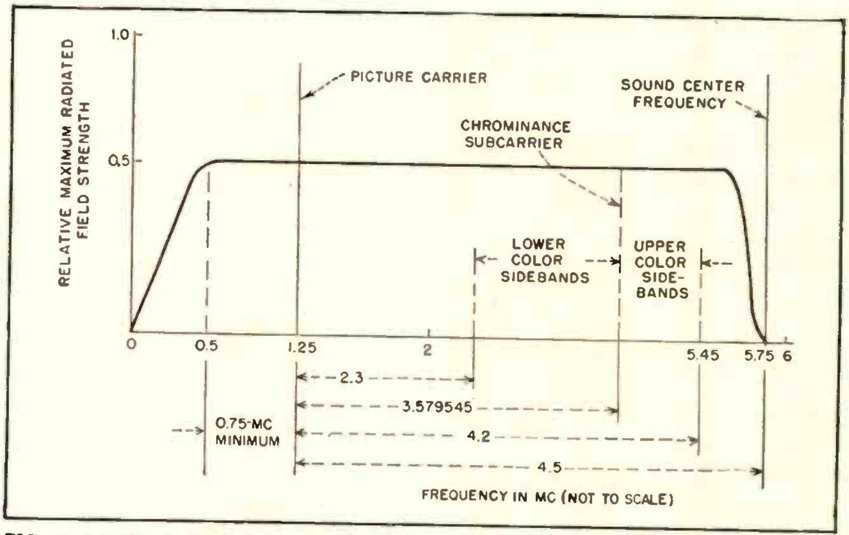


FIG. 1—Idealized transmission characteristic showing relative carrier frequencies

For most present-day monochrome i-f amplifiers, the bandwidth at 6 db down from the flat top of the response is between 3 and 3.5 mc. This means the response to the chrominance subcarrier and its upper sidebands is down appreciably from the flat top of the i-f response curve. Such amplifiers are not suitable for color television because of this narrower response.

Beat Frequency

A further requirement for the color i-f system, which is in conflict with the requirement for greater bandwidth, is the need for greater attenuation at the 4.5-mc sound-carrier frequency, or 41.25 mc in terms of intermediate frequency. One reason this greater attenuation is needed is the 900-kc beat frequency produced, mainly in the second detector, by the difference between the sound-carrier and the chrominance-subcarrier frequencies.

Although, the beat is an f-m effect since the sound carrier is frequency modulated, a definite reduction in beat visibility was attained by making the average beat frequency an odd multiple of half-line frequency.[1,2] The present 20 to 30 db rejection at 41.25 mc in monochrome receivers appears sufficient to reduce the beat to a negligible level.

A further attempt to reduce this beat-frequency interference was made by reducing the maximum sound-carrier amplitude to 70 percent of the picture-carrier amplitude. However, path differences and reflections may vary this ratio considerably.

Sound-Carrier Attenuation

Another reason for requiring greater attenuation at the sound-carrier frequency has to do with only the color receiver. While attenuation can be at 4.5 mc in the chrominance band-pass circuits, considerably more rejection is required in the i-f section before detection than is present in a monochrome receiver. The 4.5-mc beat note is amplitude modulated to some extent with the luminance information and the sidebands resulting from this modulation can cause crosstalk in the chrominance signal even though the 4.5-mc carrier has been attenuated.

Since the depth of luminance amplitude modulation of the 4.5-mc sound signal is a function of the relative levels of sound and picture signals, the more sound-carrier attenuation in the i-f relative to picture carrier, the lower will be the relative importance of the amplitude-modulated sidebands of the 4.5-mc signal.[3] Sufficient attenuation must be added at 3.58 mc and 4.5 mc in the video section of the color receiver to eliminate any dot patterns.

The necessary sound-carrier attenuation in the i-f section of the

Conversion for Color

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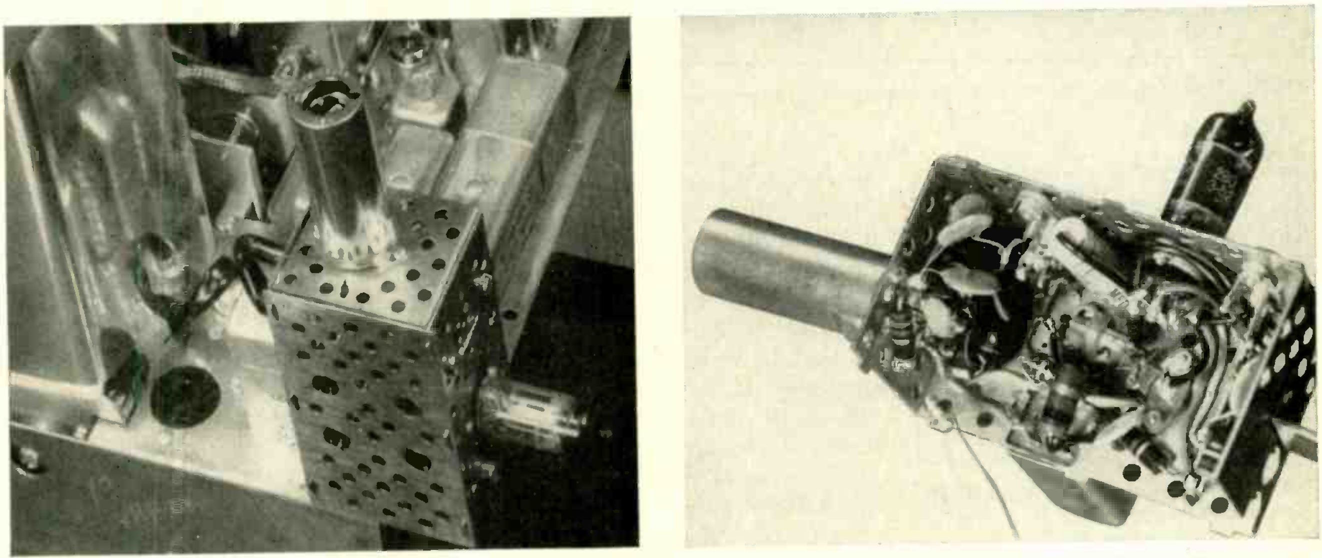


Modification unit mounts on chassis near intercarrier-detector. Unit includes an i-f stage, video detector and cathode follower output

color receiver has been found to be 45 to 50 db with respect to the curve top, with the lower figure applying to a crystal detector as compared to a thermionic detector. Because of its better linearity with a few volts output and the elimination of a filament a crystal detector lowers the effect of the 900-kc beat.

To avoid sacrificing sound sensitivity, the 41.25-mc sound attenuation at the 4.5-mc i-f takeoff point must be maintained at the 20 to 30 db figure, as with monochrome receivers. This requires the arrangement shown in Fig. 2, where the sound is taken off and further attenuation is added at 41.25 mc before the video frequencies are taken out. Separate detectors are required for sound and video frequencies.

Converted I-F Strip

The schematic of a monochrome i-f amplifier adapted for color is shown in Fig. 3. The original monochrome i-f strip had only four 6CB6 stages, with the output from the CK706 crystal detector fed from the 4th i-f stage giving sound, synchronizing and video circuit input voltages. In addition, there were 15,000-ohms and 10 $\mu\mu$f in parallel across the primary of the detector input transformer.

To adapt the i-f strip for color, it was necessary to remove these two components and take off from the secondary of the detector input transformer. The signal is coupled through the 22-$\mu\mu$f capacitance to the grid of the 6CL6 5th i-f stage in the added outboard unit.

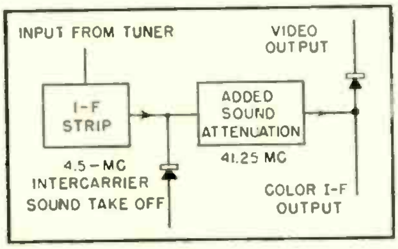


FIG. 2—Block diagram showing separate color i-f, sound and video takeoffs

The 22-$\mu\mu$f capacitance, in conjunction with the input admittance of the 6CL6 at 40 mc and stray and wiring capacitances to ground, gives the same loading as the removed resistor and capacitor. Therefore, i-f response up to this point is not changed.

Filter Characteristics

The 6CL6 drives a band-pass filter with a bridged-T section to give high attenuation at the 41.25-mc sound carrier and a sharp corner frequency as shown in Fig. 4.

There is a valley at the midband frequencies to secure some extension in bandwidth at the higher video frequencies. The peak at 41.65 mc corresponds to a 4.12-mc video frequency, which is about the upper limit for chrominance sidebands. This peaking may be overdone because it results in some loss of gain and makes the 6CL6

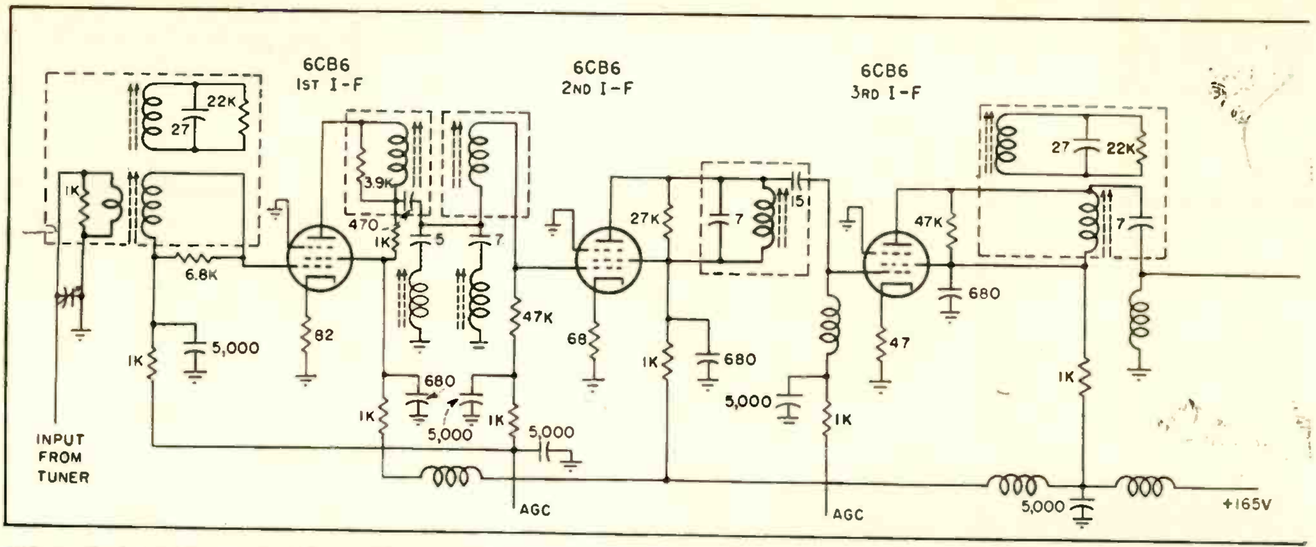

6CB6
1st I-F
6CB6
2nd I-F
6CB6
3rd I-F
22K
27
1K
6.8K
5,000
1K
82
3.9K
470
1K
5
7
47K
680
5,000
1K
1K
5,000
27K
7
151
68
1K
680
5,000
1K
47K
680
47
27
22K
7
1K
5,000
+165V
AGC
AGC
INPUT FROM TUNER

FIG. 3—Standard intercarrier i-f amplifier adapted for color. Conversion is made by taking signal from secondary of intercarrier sound

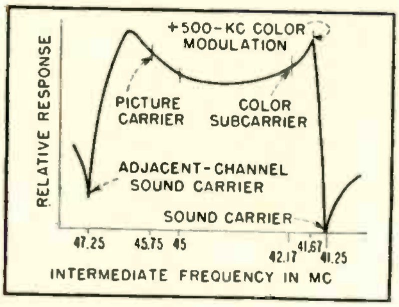


FIG. 4—Response obtained through 5th i-f stage shown in Fig. 3

more subject to overload. Also, a slight tuning adjustment must be made in other parts of the i-f strip to give an overall flat response.

The position of the video carrier at 6 db below the flat top on the overall curve is maintained by adjustment of the staggered i-f coil, which is tuned close to the video carrier frequency of 45.75 mc.

The crystal video detector drives a 6AH6 cathode follower. This is due to the color-set design, which attempted to utilize as much of the monochome set as possible. This was feasible because of the multi-unit type of monochrome set used, which includes r-f/i-f, deflection and high-voltage sections.

Since synchronizing, sound and deflection circuits are nearly identical for color and monochrome sets, only the high-voltage rectifier of the monochrome set was not utilized.

The color circuits were all located on a separate chassis driven with video through coaxial line

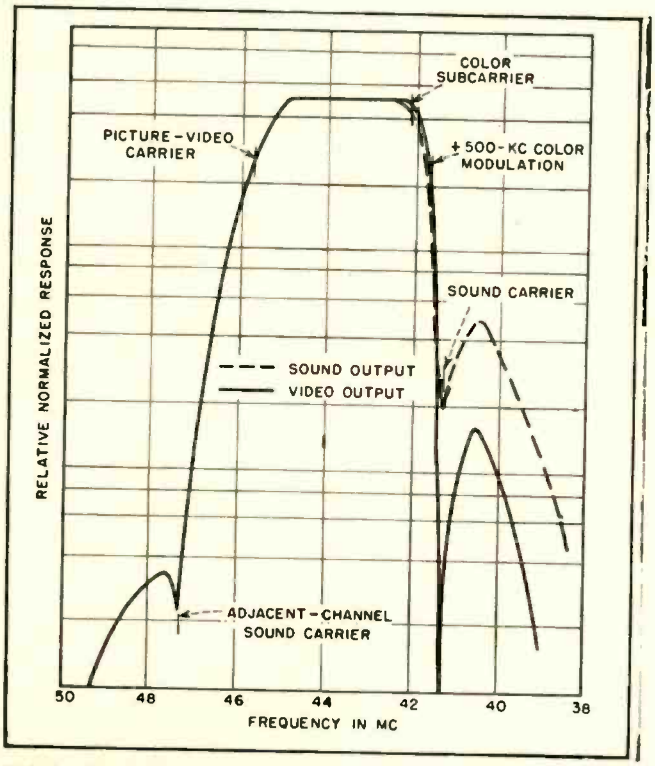


FIG. 5—Normalized responses at sound and video i-f outputs

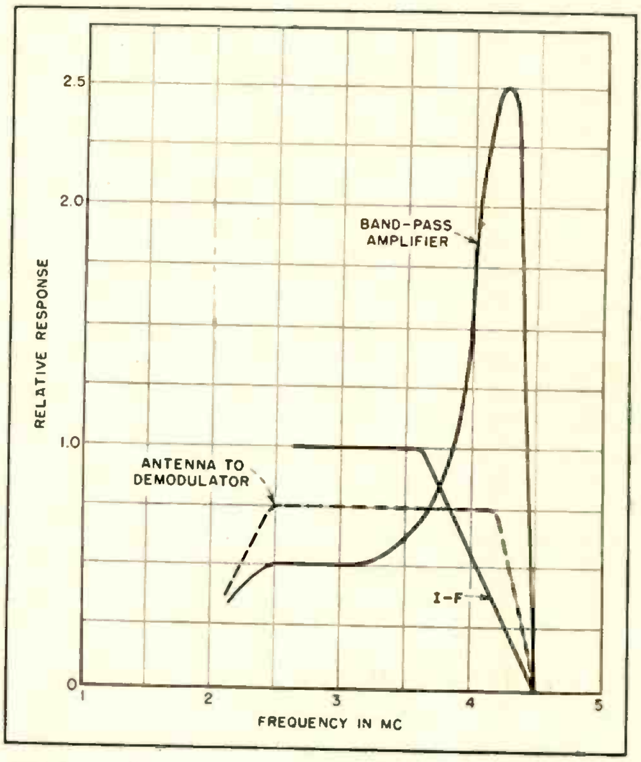
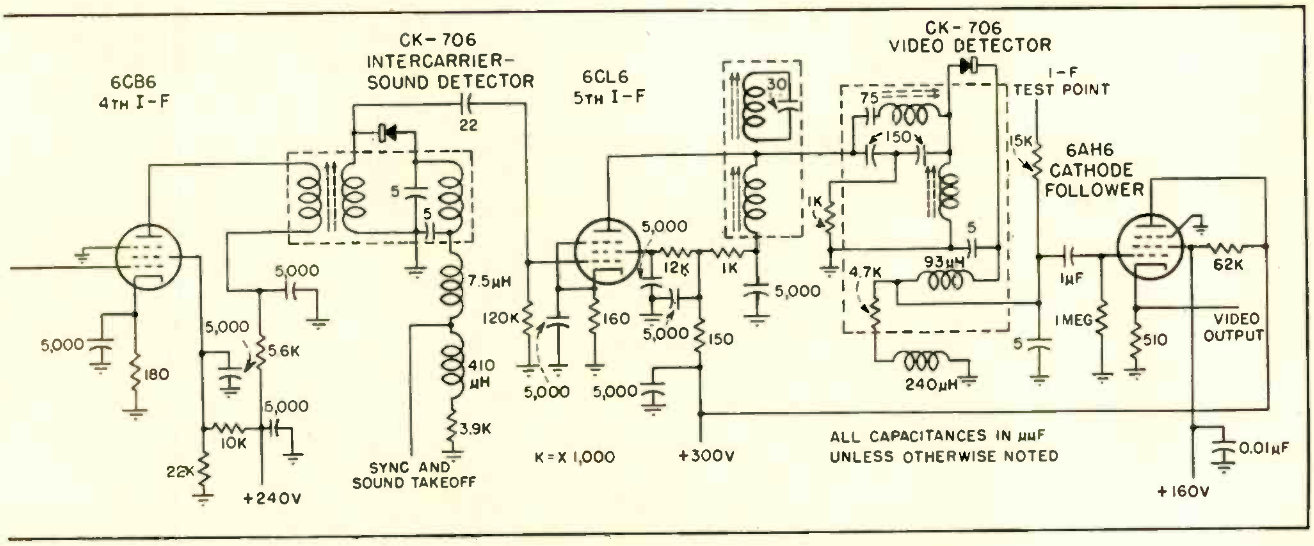


FIG. 6—Receiver response for encoded chrominance information



detector transformer and feeding it through a coaxial line to a 5th i-f stage in the modification unit

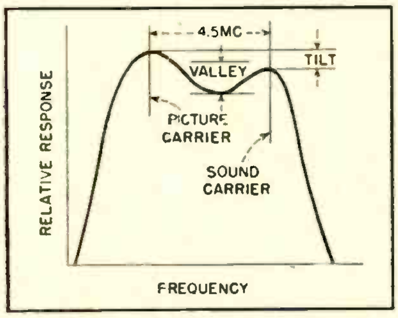


FIG. 7—Typical monochrome receiver tuner response

from the 6AH6 cathode follower on the r-f/i-f chassis.

Gain

The overall gain of the 5th i-f and cathode follower is 7 to 10 db as compared to the sound and sync takeoff (also previous monochrome video takeoff) resulting in about six-volts peak-to-peak video to drive the color chassis. There is about 3 db attenuation across the 22-μμf 6CL6 input coupling capacitance. If this attenuation were not present, it would be necessary to cut the input to the 6CL6 by readjusting the agc level to keep the video output down to the proper level. This would complicate the compatible aspect of the design. In addition, since the gain-bandwidth product of the 4th i-f stage is given by $g_m/2\pi C$, where g_m is the transconductance of the tube and C is the total tuned circuit capacitance, it is necessary, to maintain the proper overall response, that C not be increased.

The photographs show external and internal views of the added color modification unit. The input is taken from the secondary of the sound detector input transformer, which is available under the cover enclosing the intercarrier sound detector crystal, by coaxial line through a hole in the cover. The output jack is located at the lower right beneath the 6AH6 cathode follower. The power plug, which feeds B+ and filament voltages to the unit from the color chassis is located above the 6AH6. The 6CL6 is the tube on top. The side containing the input socket and the cover were made removable to facilitate servicing and construction. Both are held in place by twisted metal tabs. The can is perforated as a cooling aid.

Output Response

Normalized response curves of the outputs at the sound and video detectors are shown in Fig. 5. The sound detector output is actually negative but is shown positive for comparison. The color subcarrier is located at the corner of the curve with the highest chrominance sidebands about 7 db down with respect to the curve top. The wider bandwidth at the video output is due to the peaking in the 5th i-f stage.

If upper and lower sidebands are not equal in amplitude for the overall chrominance channel, color crosstalk occurs, resulting in picture contamination. The crosstalk is due to the quadrature type of encoding and decoding used for the color information.[4] To bring the upper chrominance sidebands up to the same level as the lower sidebands, the video color information may be passed through a band-pass amplifier having the type of response shown in Fig. 6. Some chrominance ringing occurs due to this peaking. Therefore, it is advisable to use as little peaking as necessary.

System Response

With respect to the overall response, a word should be said about tuners. It does no good to take great pains to secure an i-f response flat to ±½ db tolerance only to find there is a 3 to 6 db tilt or valley in the tuner frequency response. A typical tuner response showing these effects is shown in Fig. 7.

It is quite likely that tuner tolerances will have to be tightened to the order of ±1 db for satisfactory color information. Antennas also may have to be held to this flatness tolerance . A result of the subcarrier being too far down on the overall response is loss of synchronization of the color subcarrier reference oscillator in the receiver, with resultant loss of all color information.

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Feedback in Junction

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VARIATION of circuit properties with feedback is of considerable importance in transistor circuits. Analysis of several single-stage transistor feedback circuits shows that matched input and output impedance, sensitivity and circuit gains can be controlled to a large extent by feedback techniques.[1]

The analysis of transistor circuits by use of four-parameter equivalent circuits[2,3] can be simplified if the full versatility of these equivalent circuits is utilized. When feedback[4] or biasing[5] elements are present in each stage, these elements and the transistor equivalent circuit can be incorporated. The result is one four-parameter equivalent circuit to replace each stage. If transistors are cascaded, adjacent single-stage equivalent circuits can be incorporated into one two-stage equivalent circuit. This process may be repeated until the complete amplifier is represented by one four-parameter equivalent circuit. Feedback between stages presents no additional problem if the feedback paths do not cross.

Equivalent Circuits

In analyzing linear operation of junction transistors, two types of equivalent circuits are particularly useful: a mesh-derived circuit taking the form of a *T* and a nodal-derived circuit in the form of a π. The general forms of these two equivalent circuits are shown in Fig. 1. They are applicable at frequencies for which the effects of reactive elements are negligible.

Equivalent circuits of this type can be used for any transistor connection. Figure 2 shows the specific equivalent circuits for each connection. To reduce the number of

Table I—Summary of Network Coefficients

Coefficient	Grounded Base	Grounded Emitter	Grounded Collector
Mesh-derived			
r_{11}	$r_e + r_b$	$r_b + r_e$	$r_b + r_c$
r_{12}	r_b	r_e	$r_c - r_m$
r_{21}	$r_b + r_m$	$r_e - r_m$	r_e
r_{22}	$r_c + r_b$	$r_c - r_m + r_e$	$r_c - r_m + r_e$
Nodal-derived			
g_{11}	$\frac{r_c + r_b}{r}$*	$\frac{r_c - r_m + r_e}{r}$	$\frac{r_c - r_m + r_e}{r}$
g_{12}	$-\frac{r_b}{r}$	$-\frac{r_e}{r}$	$-\frac{r_c - r_m}{r}$
g_{21}	$-\frac{r_b + r_m}{r}$	$-\frac{r_e - r_m}{r}$	$-\frac{r_e}{r}$
g_{22}	$\frac{r_e + r_b}{r}$	$\frac{r_b + r_e}{r}$	$\frac{r_b + r_c}{r}$

* $r = r_{11}r_{22} - r_{12}r_{21}$

Table II—Network Coefficients for Cascaded Pairs

	Individual Transistor Representation		Network Coefficient*			
Mesh-derived resultant	1st Transistor	2nd Transistor	r_{11}	r_{12}	r_{21}	r_{22}
1	mesh	mesh	$\frac{r'_{11}r''_{11}+r'}{r''_{11}+r'_{22}}$	$\frac{r'_{12}r''_{12}}{r''_{11}+r'_{22}}$	$\frac{r'_{21}r''_{21}}{r''_{11}+r'_{22}}$	$\frac{r''+r'_{22}r''_{22}}{r''_{11}+r'_{22}}$
2	mesh	nodal	$\frac{r'_{11}g''_{22}+r'g''}{g''_{22}+g''r'_{22}}$	$-\frac{r'_{12}g''_{12}}{g''_{22}+g''r'_{22}}$	$-\frac{r'_{21}g''_{21}}{g''_{22}+g''r'_{22}}$	$\frac{1+r'_{22}g''_{11}}{g''_{22}+g''r'_{22}}$
3	nodal	mesh	$\frac{r''_{11}g'_{22}+1}{g'_{11}+g'r''_{11}}$	$-\frac{r''_{12}g'_{12}}{g'_{11}+g'r''_{11}}$	$-\frac{r''_{21}g'_{21}}{g'_{11}+g'r''_{11}}$	$\frac{r''_{22}g'_{11}+r''g'}{g'_{11}+g'r''_{11}}$
4	nodal	nodal	$\frac{g'_{22}g''_{22}+g''}{g''g'_{11}+g'g''_{22}}$	$\frac{g'_{12}g''_{12}}{g''g'_{11}+g'g''_{22}}$	$\frac{g'_{21}g''_{21}}{g''g'_{11}+g'g''_{22}}$	$\frac{g'_{11}g''_{11}+g'}{g''g'_{11}+g'g''_{22}}$
Nodal-Derived resultant			g_{11}	g_{12}	g_{21}	g_{22}
5	mesh	mesh	$\frac{r'_{22}r''_{22}+r''}{r''r'_{11}+r'r''_{22}}$	$-\frac{r'_{12}r''_{12}}{r''r'_{11}+r'r''_{22}}$	$-\frac{r'_{21}r''_{21}}{r''r'_{11}+r'r''_{22}}$	$\frac{r'_{11}r''_{11}+r'}{r''r'_{11}+r'r''_{22}}$
6	mesh	nodal	$\frac{r'_{22}g''_{11}+1}{r'_{11}+r'g''_{11}}$	$\frac{r'_{12}g''_{12}}{r'_{11}+r'g''_{11}}$	$\frac{r'_{21}g''_{21}}{r'_{11}+r'g''_{11}}$	$\frac{r'_{11}g''_{22}+r'g''}{r'_{11}+r'g''_{11}}$
7	nodal	mesh	$\frac{r''_{22}g'_{11}+r''g'}{r''_{22}+r''g'_{22}}$	$\frac{r''_{12}g'_{12}}{r''_{22}+r''g'_{22}}$	$\frac{r''_{21}g'_{21}}{r''_{22}+r''g'_{22}}$	$\frac{r''_{11}g'_{22}+1}{r''_{22}+r''g'_{22}}$
8	nodal	nodal	$\frac{g'_{11}g''_{11}+g'}{g''_{11}+g'_{22}}$	$-\frac{g'_{12}g''_{12}}{g''_{11}+g'_{22}}$	$-\frac{g'_{21}g''_{21}}{g''_{11}+g'_{22}}$	$\frac{g'_{22}g''_{22}+g''}{g''_{11}+g'_{22}}$

* Single primes designate network coefficients of the first transistor. Double primes designate the network coefficients of the second transistor. Definitions of r and g are given in Fig. 5.

Transistor Circuits

Series and parallel feedback circuits for a single stage are reduced to a four-parameter equivalent circuit for analysis. Cascaded transistor stages reduced in a similar manner result in either mesh or nodal-derived equivalent circuits

parameters, each equivalent circuit is written in terms of grounded-base parameters. Table I summarizes the network coefficients for each circuit of Fig. 2.

Feedback Circuits

Feedback circuits[6] may be studied by means of the expression for return difference[7]. Using the most general transistor representations of Fig. 1, the return difference for r_4 in the mesh-derived case is

$$F = \frac{\Delta}{\Delta^0}$$

$$= 1 - \frac{r_2 r_4}{(R_g+r_1+r_2)(r_2+r_3+R_L)-r_2^2} \quad (1)$$

in terms of the equivalent circuit parameters, or

$$F = 1 - \frac{r_{12}(r_{21} - r_{12})}{(R_g + r_{11})(r_{22} + R_L) - r_{12}^2} \quad (2)$$

in terms of the network coefficients. In Eq. 1, Δ is the circuit determinant and Δ^0 is the circuit determinant with r_4 set to zero.

The determinant can now be written in the form

$$\Delta = (R_g + r_1 + r_2)(r_2 + r_3 + R_L) - r_2(r_2 + r_4) \quad (3)$$

Here R_g is included in the circuit determinant to provide a more useful measure of sensitivity. This is equivalent to defining voltage gain as

$$A_v = \frac{E_2}{E_g} \quad (4)$$

when computing the sensitivity directly.

It is evident from Eq. 2 that the transistor is inherently a feedback device depending to a large extent upon the coefficient r_{12}. Furthermore, any additions to the circuit which change the r_{12} coefficient change feedback. In this paper, additions of this kind are called added feedback.

Figure 3A illustrates three feedback circuits which control directly, but not independently, the r_{12} coefficient.

Feedback in these circuits is termed series-added feedback. Mesh-derived equivalent circuits are used because series feedback is most easily handled by mesh equations.

Nodal Derived Circuits

For the nodal-derived case, the return difference for g_4 is

$$F = 1 - \frac{g_{12}(g_{21} - g_{12})}{(G_g + g_{11})(g_{22} + G_2) - g_{12}^2} \quad (5)$$

Here G_g is included in the circuit determinant. This means that when sensitivity is computed directly, current gain must be defined as

$$A_i = -\frac{I_2}{I_g} \quad (6)$$

Equation 5 shows that feedback can be controlled by controlling the g_{12} coefficient.

The circuits of Fig. 3B illustrate three feedback circuits which control the g_{12} coefficient. Feedback in these circuits is termed parallel-added feedback since feedback elements are placed in parallel with

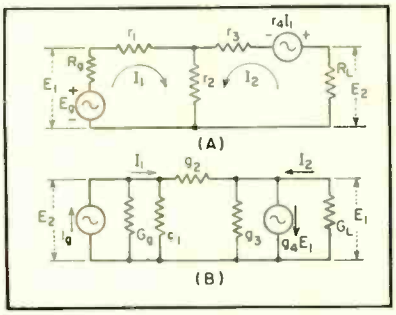


FIG. 1—Mesh-derived (A) and nodal-derived (B) equivalent circuits for junction transistors

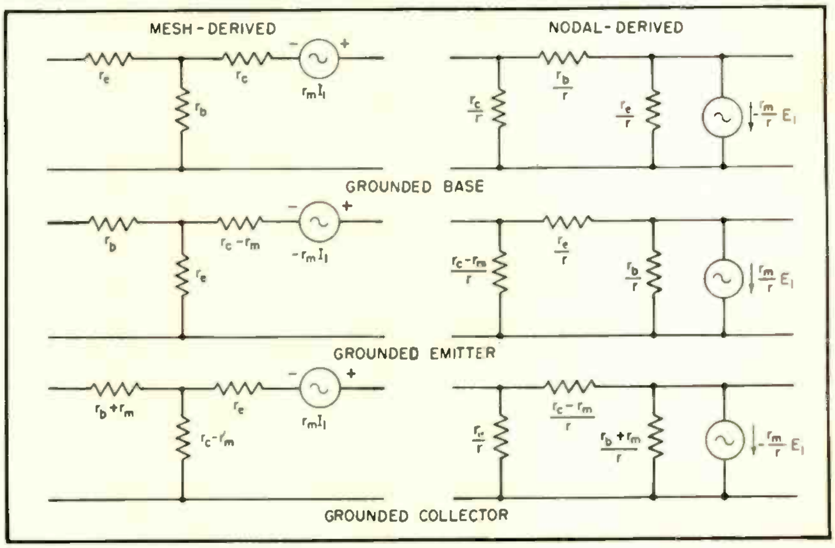


FIG. 2—Equivalent circuits for various transistor connections in mesh and nodal derived forms

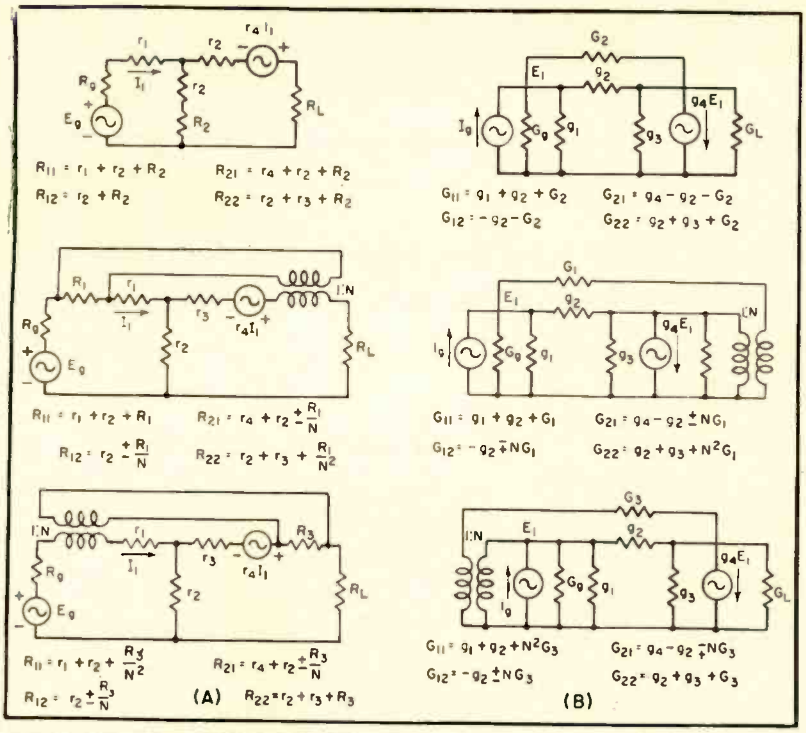

$R_{11} = r_1 + r_2 + R_2$
$R_{12} = r_2 + R_2$
$R_{21} = r_4 + r_2 + R_2$
$R_{22} = r_2 + r_3 + R_2$
$R_{11} = r_1 + r_2 + R_1$
$R_{12} = r_2 \mp \frac{R_1}{N}$
$R_{21} = r_4 + r_2 \pm \frac{R_1}{N}$
$R_{22} = r_2 + r_3 + \frac{R_1}{N^2}$
$R_{11} = r_1 + r_2 + \frac{R_3}{N^2}$
$R_{12} = r_2 \pm \frac{R_3}{N}$
$R_{21} = r_4 + r_2 \pm \frac{R_3}{N}$
$R_{22} = r_2 + r_3 + R_3$
(A)
$G_{11} = g_1 + g_2 + G_2$
$G_{12} = -g_2 - G_2$
$G_{21} = g_4 - g_2 - G_2$
$G_{22} = g_2 + g_3 + G_2$
$G_{11} = g_1 + g_2 + G_1$
$G_{12} = -g_2 \mp NG_1$
$G_{21} = g_4 - g_2 \pm NG_1$
$G_{22} = g_2 + g_3 + N^2G_1$
$G_{11} = g_1 + g_2 + N^2G_3$
$G_{12} = -g_2 \pm NG_3$
$G_{21} = g_4 - g_2 \mp NG_3$
$G_{22} = g_2 + g_3 + G_3$
(B)

FIG. 3—Network coefficients for series (A) and parallel (B) feedback circuits

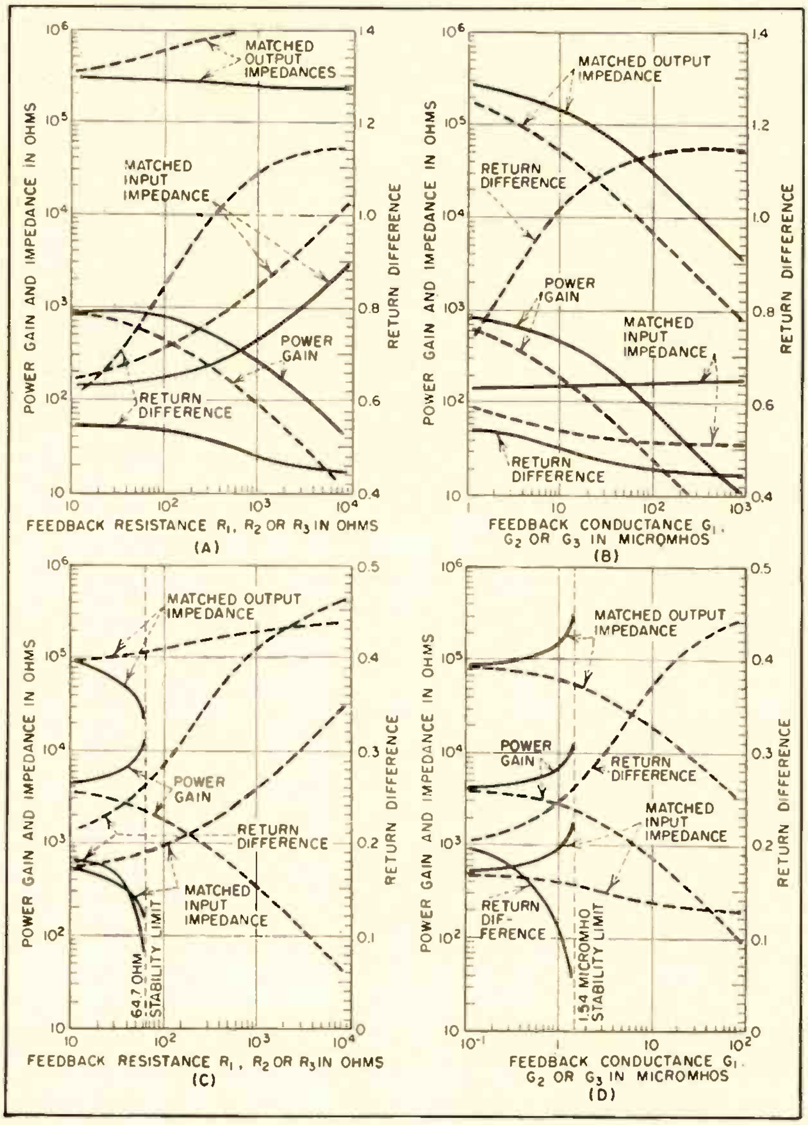


FIG. 4—Variations of circuit properties with feedback in grounded-base series (A) grounded-base parallel (B), grounded-emitter series (C) and grounded-emitter parallel (D) circuits. Dashed line indicates negative feedback

the equivalent-circuit parameters. Parallel feedback is most easily handled by nodal equations.

General Circuit Equations

In terms of the network coefficients, useful mesh-derived equivalent circuit equations are

$$R_i = \frac{r_{11}(r_{22} + R_L) - r_{12}r_{21}}{r_{22} + R_L}, \qquad (7)$$

$$R_o = \frac{(R_g + r_{11})r_{22} - r_{12}r_{21}}{R_g + r_{11}}, \qquad (8)$$

$$A_v = \frac{E_2}{E_1} = \frac{r_{21}R_L}{r_{11}(r_{22} + R_L) - r_{12}r_{21}}, \qquad (9)$$

$$A_i = -\frac{I_2}{I_1} = \frac{r_{21}}{r_{22} + R_L}, \qquad (10)$$

and

$$A_p = A_vA_i \qquad (11)$$

For the nodal-derived equivalent circuit these equations are

$$G_i = \frac{g_{11}(g_{22} + G_L) - g_{12}g_{21}}{g_{22} + G_L}, \qquad (12)$$

$$G_o = \frac{(G_g + g_{11})g_{22} - g_{12}g_{21}}{G_g + g_{11}}, \qquad (13)$$

$$A_v = \frac{E_2}{E_1} = -\frac{g_{21}}{g_{22} + G_L}, \qquad (14)$$

$$A_i = -\frac{I_2}{I_1} = -\frac{g_{21}G_L}{g_{11}(g_{22} + G_L) - g_{12}g_{21}}, \qquad (15)$$

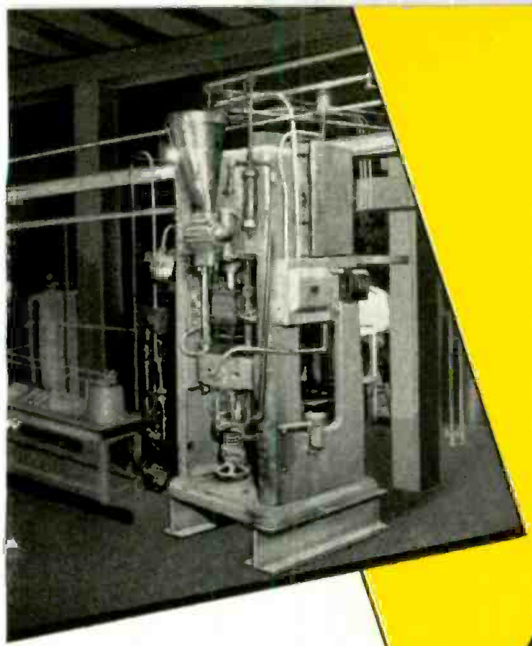
and

$$A_p = A_vA_i \qquad (16)$$

Input impedance R_i or conductance G_i is measured at the input terminals of the transistor. The output impedance R_o or conductance G_o is measured at the output terminals. Voltage gain A_v and current gain A_i in both cases are the gains from input to output terminals.

When feedback is added to single-stage transistor circuits these general circuit equations may still be used providing the proper network coefficients, shown in Fig. 3, are used. The latter definitions are different from the definition of gain used in conjunction with the calculation of return difference.

Variation of circuit properties with feedback is shown by the curves of Fig. 4. These curves illustrate the variation of input impedance, output impedance, power



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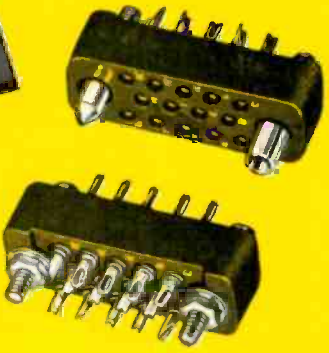

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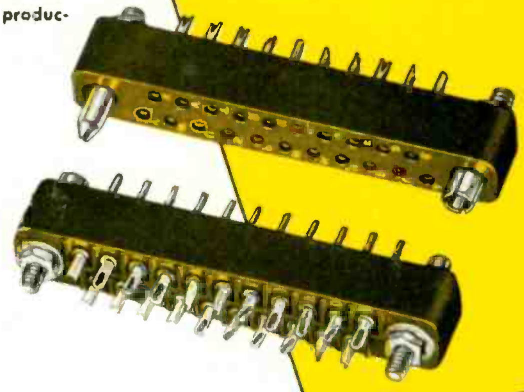

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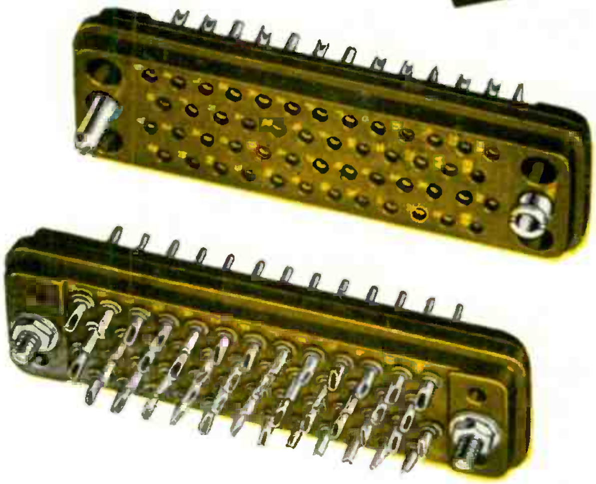

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gain and return difference for a typical junction transistor under matched conditions. Curves for both grounded-base and grounded-emitter operation are given.

The curves of Fig. 4A and 4B pertain to the grounded-base feedback circuits of Fig. 3 with the one exception that only positive added feedback can be obtained in the circuits using no transformers. A one-to-one transformer was assumed for the other circuits.

Variation of input and output impedance for series feedback is considerably different than that for parallel feedback, as can be seen from the curves. In addition, power gain tends to decrease for both positive and negative feedback and return difference can be raised by use of circuits with transformers.

The curves of Fig. 4C and D pertain to the grounded-emitter feedback circuits of Fig. 3 with the exception that only negative added feedback can be obtained from the circuits not using transformers.

In these cases, the grounded-emitter circuit becomes unstable when the added feedback is positive. The variation of input impedance, output impedance, power gain and return difference for negative feedback is similar to that of the grounded-base connection.

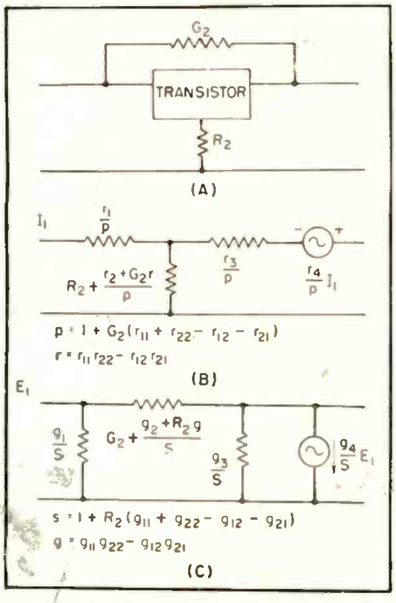
Multiple Feedback

When both series and parallel feedback are present in the same stage, an additional circuit equation is normally required. This is true regardless of whether the transistor representation is of the mesh-derived or of the nodal-derived type. However, it is possible to modify the equivalent circuit so that an additional circuit equation is not necessary.

Figure 5A illustrates a single-stage circuit with both series and parallel added feedback. To analyze this circuit, three equations would normally be required. However, if the transistor is represented by a mesh-derived equivalent circuit, the modified circuit of Fig. 5B can be used. If the transistor is represented by a nodal-derived equivalent circuit, the modified circuit of Fig. 5C can be used. In either case, two equations are sufficient.

Cascaded transistor circuits can be analyzed by a method of circuit reduction of active networks. Using this method a four-parameter equivalent circuit may be found to replace two transistors. This composite equivalent circuit can be of the mesh-derived or nodal-derived type. Except for values of the parameters it is identical to the single-stage equivalent circuits of Fig. 1.

Repeated application of this method produces one four-parameter equivalent circuit to replace a cascaded transistor circuit of any number of stages.



G_2
TRANSISTOR
R_2
(A)
I_1
$\frac{r_1}{p}$
$R_2 + \frac{r_2 + G_2 r}{p}$
$\frac{r_3}{p}$
$\frac{r_4}{p} I_1$
$p = 1 + G_2(r_{11} + r_{22} - r_{12} - r_{21})$
$r = r_{11} r_{22} - r_{12} r_{21}$
(B)
E_1
$\frac{g_1}{s}$
$G_2 + \frac{g_2 + R_2 g}{s}$
$\frac{g_3}{s}$
$\frac{g_4}{s} E_1$
$s = 1 + R_2(g_{11} + g_{22} - g_{12} - g_{21})$
$g = g_{11} g_{22} - g_{12} g_{21}$
(C)

FIG. 5—Single-stage circuit with series and parallel added feedback (A), mesh-derived equivalent circuit (B) and nodal-derived equivalent circuit (C)

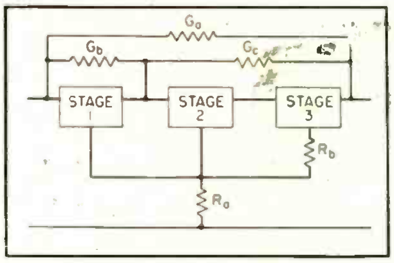


FIG. 6—Three-stage transistor circuit with both series and parallel feedback

Active Networks

Table II contains the information necessary for reducing active networks. This material was obtained by matrix methods. Two stages may be combined regardless of the type of equivalent circuit used for each transistor and the resulting equivalent circuit may be either of the mesh-derived or nodal-derived type.

To illustrate the use of this method on a three-stage transistor circuit containing both series and parallel feedback, Fig. 6 is shown.

Let the first stage be represented by a nodal-derived equivalent circuit. Then, G_b may be directly added to the network coefficients of this circuit. Let the second and third stages be represented by a mesh-derived equivalent circuit. Resistance R_b may then be added directly to the third stage. The last two stages can now be combined by use of the relationships of Table II, line 5. This resultant two-stage equivalent circuit is of the nodal-derived type. Therefore G_c may be added directly. Now, the equivalent circuit of the first stage with G_b included can be combined with the two-stage equivalent circuit with G_c and R_b included, resulting in a three-stage equivalent circuit, which may be of either the mesh or nodal-derived type.

If the three-stage equivalent circuit is obtained by use of the relationships of Table II, line 4, a mesh-derived circuit results. The conductance G_a may now be added to this circuit by the method illustrated in Fig. 5B, and R_a may be added directly.

If the three-stage equivalent circuit is obtained by use of the relationships of Table II, line 8, a nodal-derived circuit results. Here, R_a may be added to the circuit by the method illustrated in Fig. 5C, and G_a may be added directly.

Regardless of the method used, the circuit of Fig. 6 can be reduced to one active network defined by four parameters. This is applicable to cascaded circuits in general.

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SILVERLYTIC* CAPACITORS

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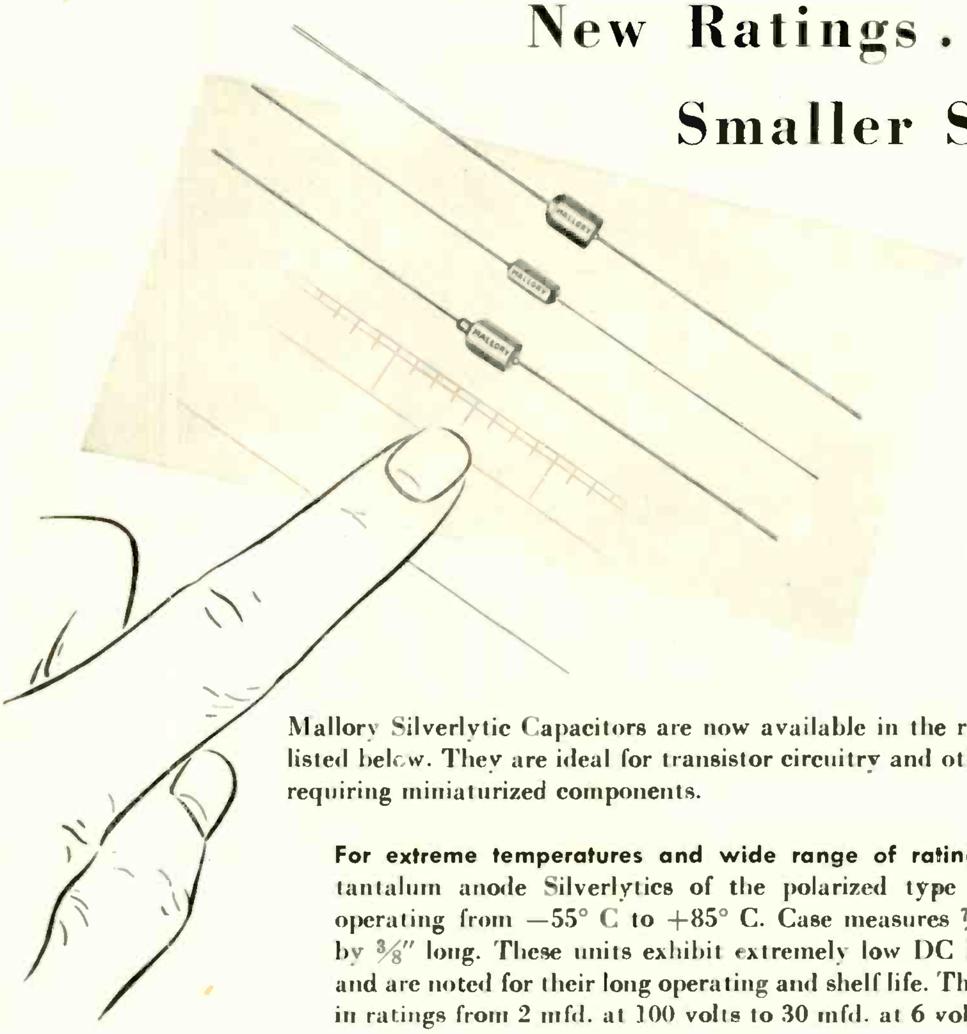

Mallory Silverlytic Capacitors are now available in the ratings and sizes listed below. They are ideal for transistor circuitry and other applications requiring miniaturized components.

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ELECTRONS AT WORK

Edited by ALEXANDER A. McKENZIE

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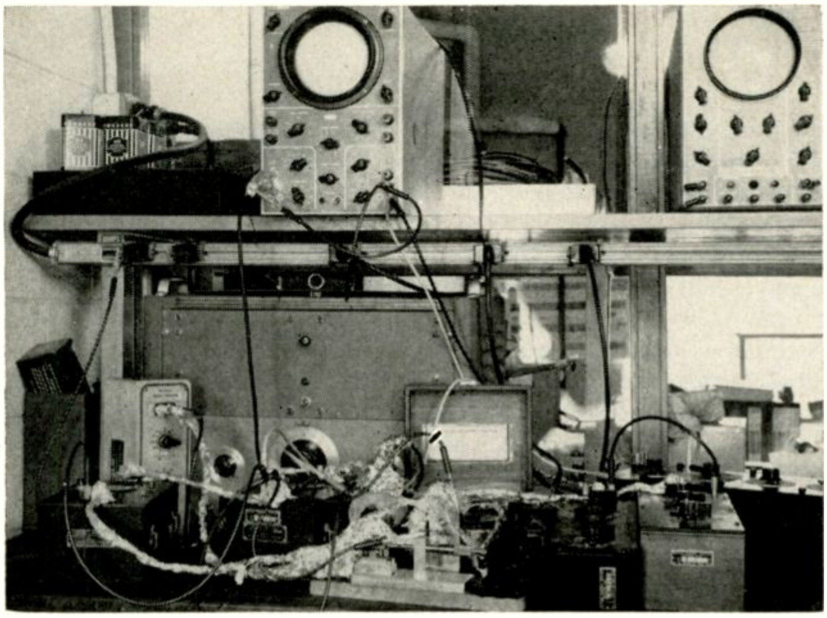
Metal Foil Used to Shield Laboratory Equipment

By Alexander Finlay

Battelle Memorial Institute
Columbus, Ohio

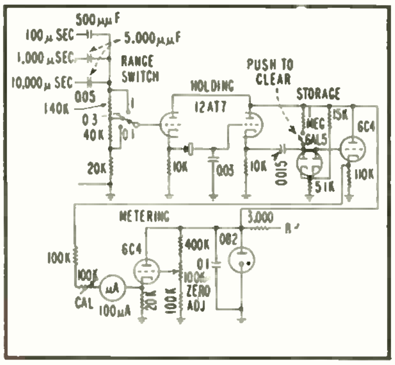


Foil shielding can be quickly applied to equipment in making laboratory tests

When large or irregularly shaped objects must be electrostatically shielded in the laboratory, mechanical difficulties are sometimes serious. Many square feet of shielding, capable of being formed into any conceivable shape can be obtained from a roll of aluminum foil. Heavy-duty freezer wrap provides excellent electrical and mechanical properties.

In cases where the foil might make an accidental electrical connection to part of the system being shielded insulation is necessary. Ordinary cellulose tape is often quite satisfactory for this purpose. This shielding system is not suitable for any permanent set-up but it does provide a tool for the research laboratory, which often results in a saving of time and effort.

Vacuum-Tube Voltmeter for Impulse Measurements



Impulse voltmeter holds transient peak voltage reading. Decay rate is about ten scale divisions per minute

By Richard F. Blake

Equipment Research Branch
Naval Research Laboratory
Washington, D. C.

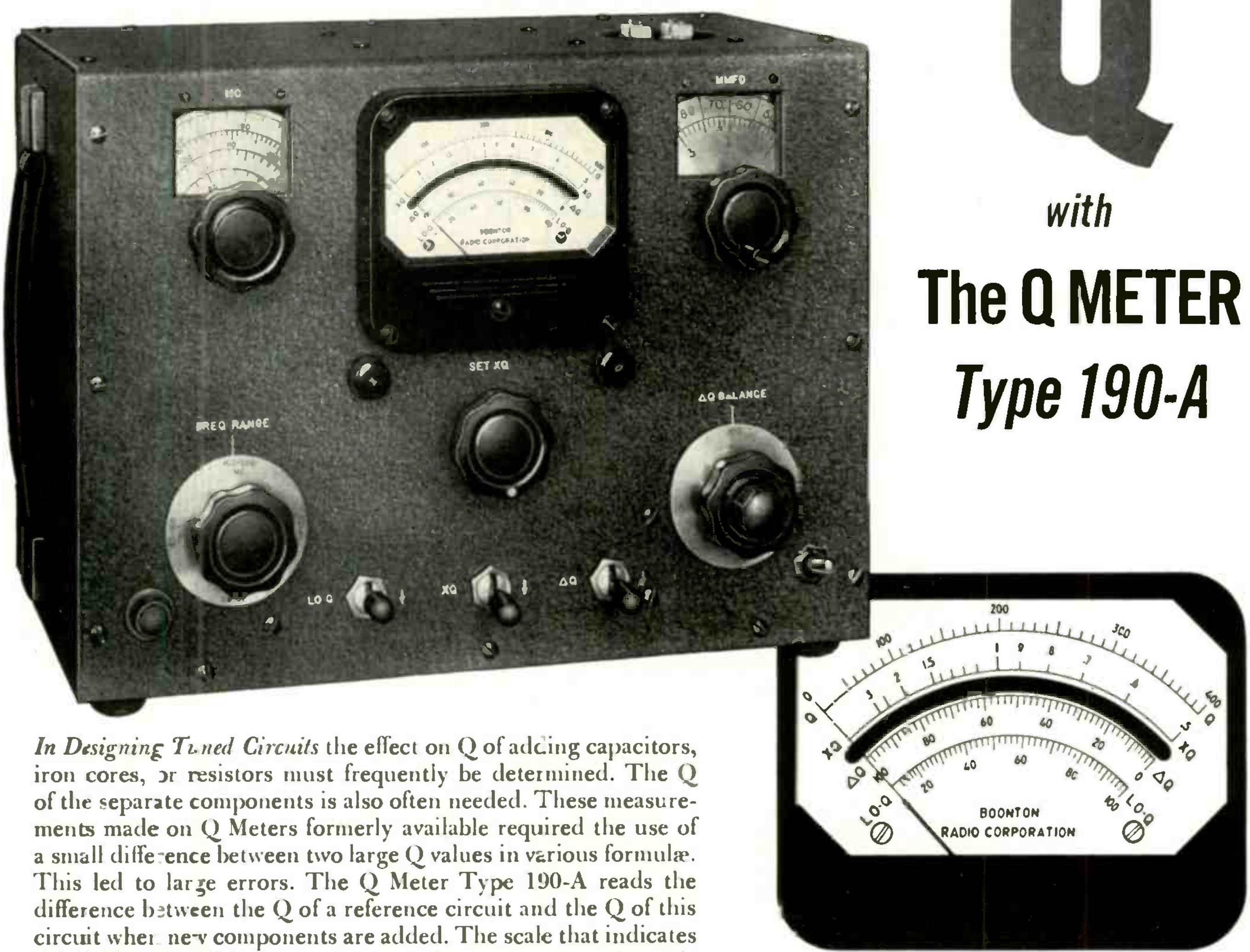
To meet a need for a means of measuring peak values of transient waveforms, the impulse vacuum-tube voltmeter shown in the diagram has been developed. Stability and accuracy of the instrument are equivalent to those of a conventional vtvm. Response time is 150 μsec permitting use on a variety of waveforms. On waves with a shorter duration than 150 μsec the instrument will no longer record absolute value but will give relative readings between waveforms of the same shape.

The holding circuit uses a high-impedance vacuum-tube voltmeter

Measure Difference In Q

with

The Q METER Type 190-A



In Designing Tuned Circuits the effect on Q of adding capacitors, iron cores, or resistors must frequently be determined. The Q of the separate components is also often needed. These measurements made on Q Meters formerly available required the use of a small difference between two large Q values in various formulæ. This led to large errors. The Q Meter Type 190-A reads the difference between the Q of a reference circuit and the Q of this circuit when new components are added. The scale that indicates this *Differential Q* has a sensitivity 4 times as great as the scale which reads *Q*. The accuracy and ease with which *Differential Q* can be read is greatly improved by use of the *190-A Q Meter*.

The Q Meter Type 190-A has a "Lo Q" scale which reads Q down to a value of 5. The internal resonating capacitor is directly read and has a vernier arrangement for accurate reading of capacitance. The dial rotates approximately 10 times in covering the capacitance range. All readings are made on a single meter corrected for parallax.

SPECIFICATIONS

FREQUENCY COVERAGE: 20 mc to 260 mc. Continuously Variable in Four Ranges.

FREQUENCY ACCURACY: Calibrated to ± 1%.

RANGE OF Q MEASUREMENTS: 5 to 1200.

RANGE OF DIFFERENTIAL Q MEASUREMENTS: 0 to 100.

ACCURACY OF Q MEASUREMENTS: Circuit Q of 400 read directly on meter can be determined to accuracy of ± 5% to 100 mc and to ± 12% to 260 mc.

INTERNAL RESONATING CAPACITANCE RANGE: 7.5 mmf to 100 mmf (direct reading) calibrated in 0.1 mmf increments.

ACCURACY OF RESONATING CAPACITOR: ± 0.2 mmf to 20 mmf
± 0.3 mmf to 50 mmf
± 0.5 mmf to 100 mmf

POWER SUPPLY: 90-130 volts—60 cps (internally regulated). Power Consumption—55 watts.

(Specifications subject to change without notice)

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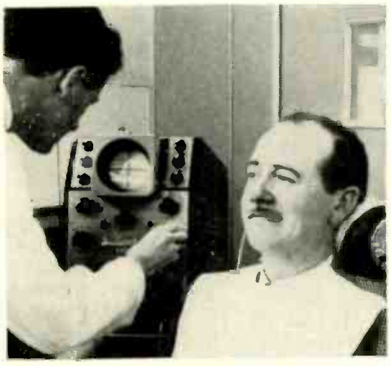
design. To achieve fast response a crystal-diode short time-constant circuit is used to stretch the duration of the applied signal before feeding it to the storage capacitor. When the transient is applied to the capacitor its output attempts to go positive causing the 6AL5 diode to conduct until the 0.015-μf storage capacitor is charged negatively to a voltage equal to the positive peak of the applied voltage. When the transient returns to zero the voltage of the storage capacitor is applied to the grid of the 6C4 in the metering circuit.

The metering circuit is limited in the amount of negative voltage it can measure by tube cutoff. To increase the range, a positive bias is inserted in the cathode of the diode. The grid signal then goes negative with respect to the bias rather than with respect to the zero value.

The instrument is calibrated by applying a known step voltage to the input and adjusting the 100,000-ohm resistor in the metering circuit for the proper indication. A three-position switch provides scale sensitivities of 30, 100 and 300 volts.

Mobile TV Control Room

Swiss mobile television unit recently completed by British Marconi includes control console. Sound controls are in the right foreground. Producer's program controls are at left. Behind are three monitor scopes



Oscilloscope Shows Denture Strain

Research in detection of strain in ill-fitting dentures is being carried on by Edinburgh Hospital and School in Scotland. Strain gage connected by wire to oscilloscope gives visible indication of defects. Permanent record can be obtained by photographing oscilloscope display

Series Capacitors Multiply Battery Voltage

By J. M. Reed
National Schools
Inglewood, Calif.

A COMMON METHOD of building up a high voltage has been to charge capacitors in parallel and discharge them in series. Capacitors operated thus will produce a terminal voltage equal to the battery voltage times the number of capacitors in series.

To obtain 6,000 volts from a 100-volt battery would require 6,000/100 or 60 capacitors. It is evident that such a large number of capacitors is not practical from the standpoint of cost, bulk and resulting capacitance.

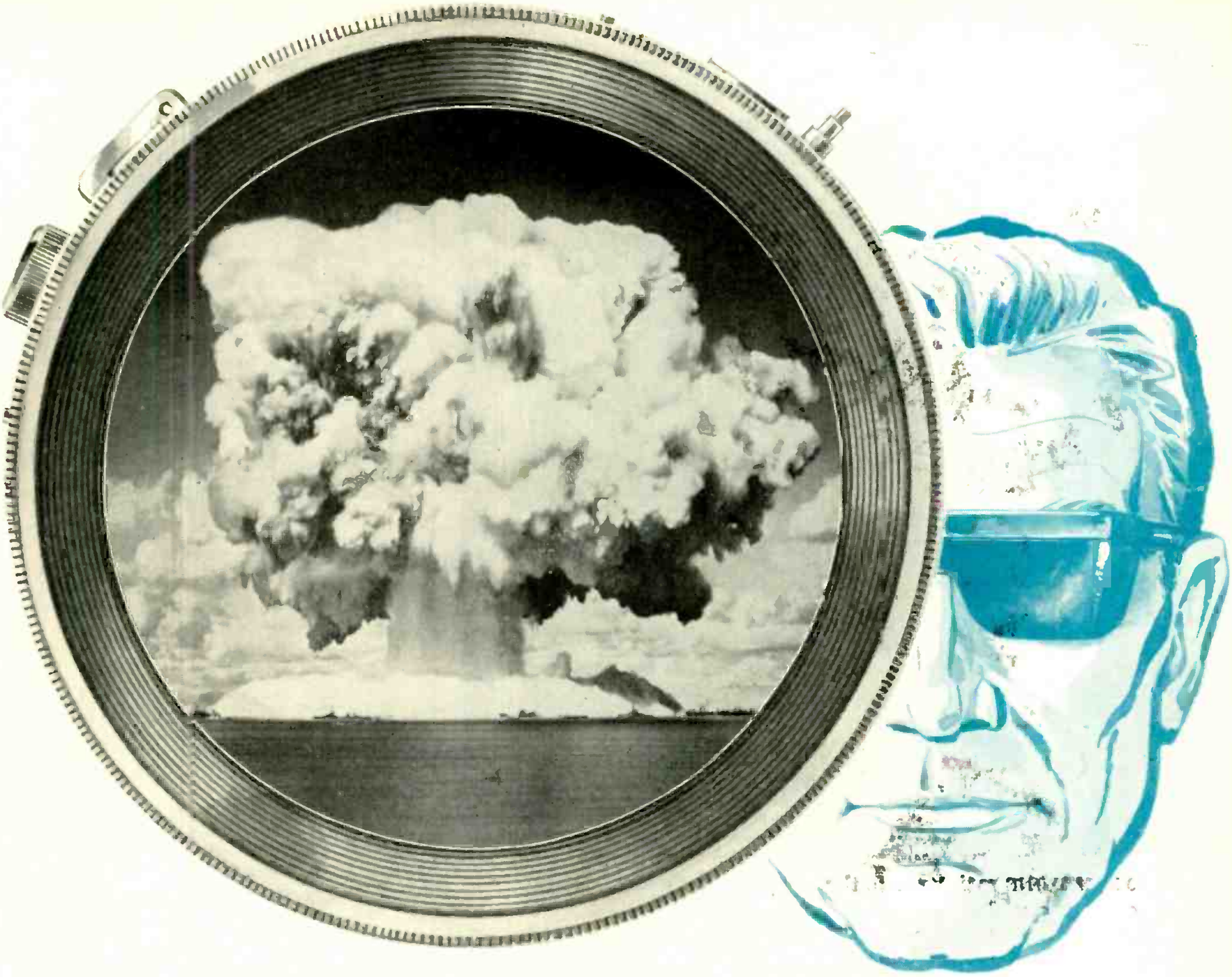
The method to be described produces 6,400 volts using only six series capacitors with a 100-volt battery. Any voltage from 100 to 100,000 volts or more can be built up. There is no top limit of voltage except the voltage break-down of the dielectric.

Battery-operated high-voltage supply produces 2,880-volt output from 90-volt source

The six capacitors are arranged so that the first has twice the capacitance of the second, the second is twice the capacitance of the third and so on. The first capacitor is charged to 100 volts by the battery.

This capacitor is then placed in series with the battery and the combination charges the second capacitor to a voltage somewhat less than 200 volts. If the first capacitor is recharged several times and discharged in series with the battery, the second capacitor will eventually obtain a charge of 200 volts.

These two capacitors and the battery are now placed in series and used to charge a third capacitor. This capacitor will take a charge



how to stop an h-blast

WANTED: a camera to stop the action of a nuclear explosion at a pre-selected microsecond, with high quality image-definition . . . that was the problem handed by the AEC and its Los Alamos Scientific Laboratory to the Boston firm of Edgerton, Germeshausen & Grier, Inc. EG&G solved it by inventing the non-mechanical Rapatronic shutter . . . employing the Faraday Effect of magnetically rotating the plane of polarized light as it traverses an optical element . . . and relying on HELIPOT* precision potentiometers and DUODIAL* turns-counting dials for sensitivity setting and calibration.

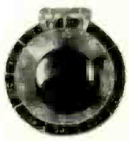
A light-pulse from the blast falls on a photocell . . . generates a signal that passes through a variable time-delay to trigger a condenser-discharge circuit . . . releasing energy which surges through a coil wound around a lead-glass lens. The resulting magnetic field rotates polarized light from the blast as it passes through the lens . . . effecting a one-microsecond exposure.

Sensitivity of the photocell circuit is controlled by a standard-linearity Model A 10-turn HELIPOT, calibrated with a Model RB DUODIAL. Time-delay from photocell pick-up to shutter operation . . . continuously variable from 0 to 100 microseconds . . . is controlled by a Model A 10-turn HELIPOT of 0.1% linearity, calibrated with a Model W10 DUODIAL.

The coil of the HELIPOT is wound with more than 10,000 turns of resistance wire . . . the DUODIAL is settable to a fraction of any of its thousand scale-divisions . . . and the Rapatronic shutter can be tripped at any preselected fraction of a microsecond.

For complete details of this and other HELIPOT applications, write for Data File 701.

MODEL A HELIPOT



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342

somewhat less than 400 volts but after several rechargings will attain exactly that value.

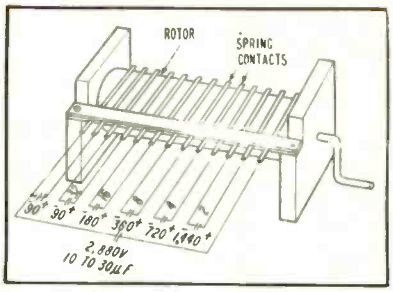


FIG. 1—Switching unit used to build up 90-volt battery output to 2,880 volts

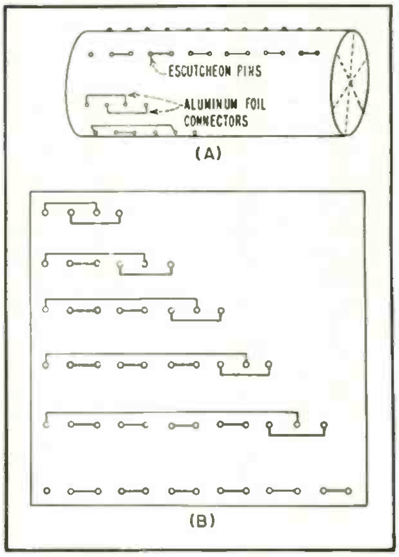


FIG. 2—Rotor unit (A) wired as shown in (B) is used to connect capacitor across battery potential and then connect charged capacitor in series with battery and next capacitor to be charged

This process of charging an additional capacitor to a voltage double the previous one is continued as often as desired. Each capacitor added to the series hook-up doubles the available voltage. With the six-series capacitor, the voltage of a 100-volt battery is built up to 6,400 volts. The addition of another capacitor would double this voltage to 12,800 volts. The terminal or final voltage obtainable is given by

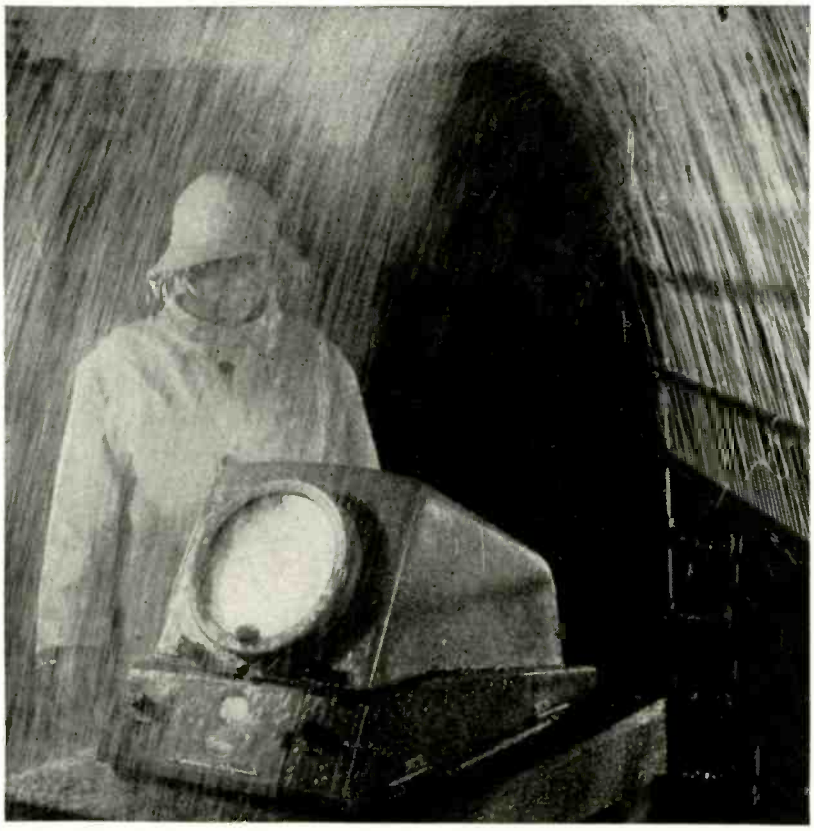
$$E_T = 2^N E_B$$

where E_T = final terminal voltage,
N = number of series capacitors,
E_B = battery or starting voltage.

The capacitors can be of any value so long as they keep an approximate ratio of two-to-one. The final voltage from a system of this sort can be used to charge a much larger capacitor where higher power is needed.

For example, the series combination could be used to charge a 30 µf or larger capacitor even though the total capacitance of all the series capacitors is less than 1 µf. Once the storage capacitor reaches terminal voltage, the charge and discharge currents die out reducing

THE FRONT COVER



TO DETERMINE resistance to the most severe dripping water, spray or rain conditions likely to be encountered for the type craft for which the system is designed, a Raytheon Mariners Pathfinder model 1500 radar indicator-receiver and antenna-transmitter is shown subjected to a water spray test.

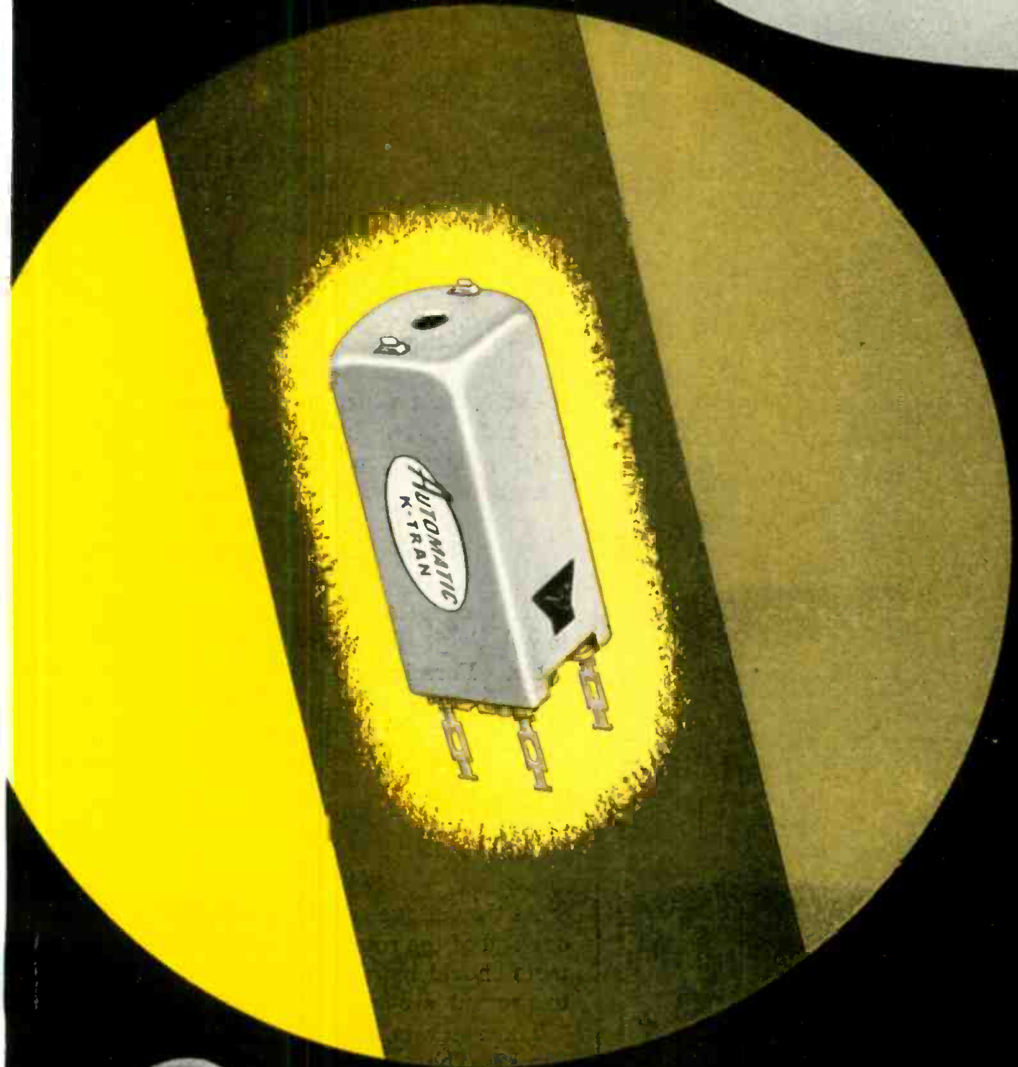
Navigation under adverse weather conditions, one of the prime benefits of commercial radar, can only be accomplished by total exclusion of water entry into the unit enclosure or by controlling the degree and area of such entry and subsequent path of any flow.

The spray rack shown comprises tiers of horizontal half-inch pipes spaced six inches, closed at one end and individually connected at the other end through gate valves to a vertical manifold. This assembly is mounted on an angle-iron frame, castered for portability and adjustment. The manifold is connected through a flexible rubber hose to a wall faucet.

A row of holes was drilled along the length of each pipe one inch apart, using a 64 drill. These horizontal sections of pipe are only made hand tight, thereby allowing control, by rotation of the pipe, of the angle of contact of the spray with the specimen undergoing test. Pressure is adjustable at the inlet to the system, up to full main pressure of 80 psi. This rack will produce a simulated rainfall over an approximate six-foot-square area in excess of 10 inches an hour.

An allied test involves subjecting the unit to a fog produced by water fog head designed for fire protection installations. This is a Rockwood Sprinkler Co. type L-12A, installed on a one-inch pipe operating under a dynamic pressure of 40 psi at the foghead. The unit under test is mounted directly below the fog head, which is 10 feet 6 inches above the floor level.

K-TRANS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the battery drain to that owing to leakage in the dielectric.

This system is being used to operate a 900-volt Geiger tube from a single 67½-volt battery and a 2,200-volt strobe-flash bulb from a 300 volt battery.

The switching of the capacitors in the proper sequence is done by turning a small hand-cranked rotor.

About five seconds are required to crank the voltage up to the final value, depending upon the output voltage wanted and the capacitance of the final storage capacitor across the output. Figure 1 shows the general construction of the rotary switch. The frame is wood or hard fiber. The rotor is wood or plastic. Spring contacts are made from brass spring ribbon, ⅛-inch wide by 0.03 in. thick.

Spring contacts slide over the heads of small escutcheon pins to make contacts. The wiring is done on the rotor with ⅛-inch wide aluminum foil. The escutcheon pins make contact when driven through the foil. After the wiring is completed, plastic tape is laid over the aluminum foil wiring to insulate it and prevent damage. Rotors wired with printed circuit techniques should be satisfactory.

It is essential that there be very low leakage between spring contacts. Formica strips having low leakage were used to clamp the springs. Springs were cemented in place with sealing wax. A grooved plastic strip would be more serviceable.

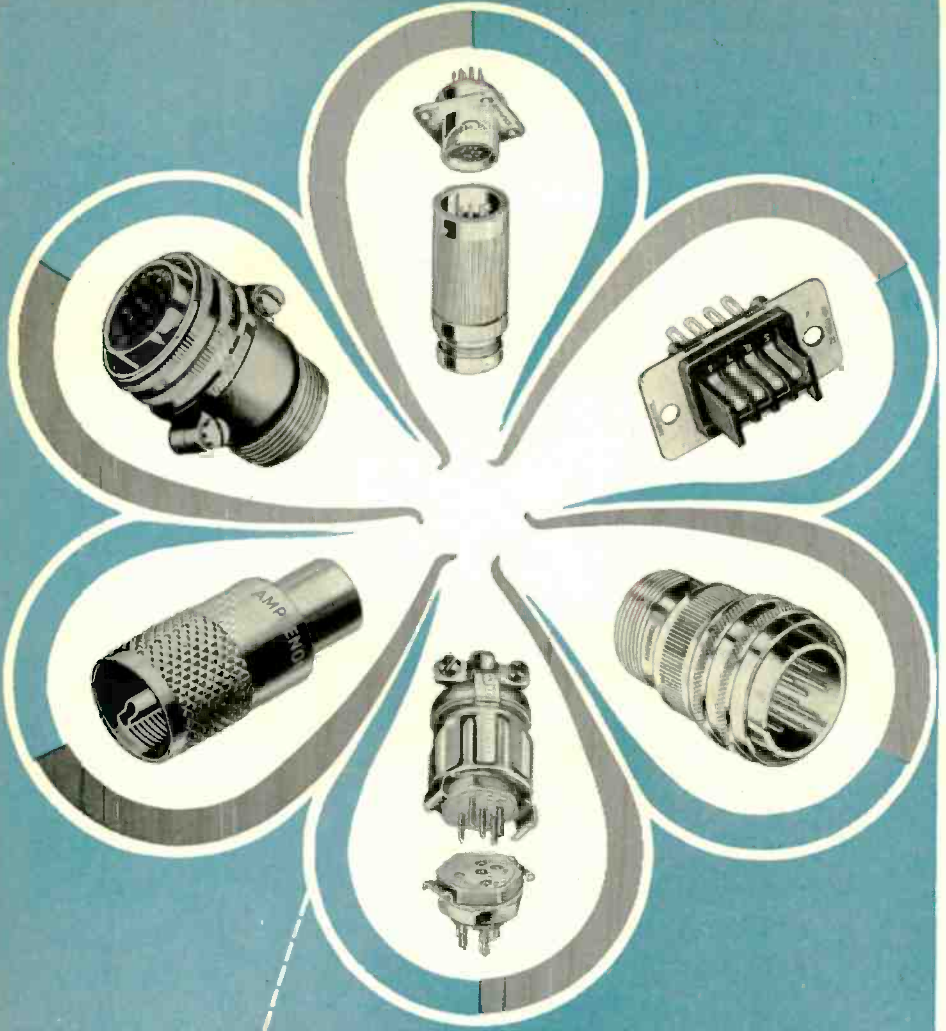
Contact Spacing

As the voltage gets higher toward one end of the rotor, the spring contacts should be more widely spaced to prevent arc-over.

The rotor is wired as shown in Fig. 2. The sequence is shown to obtain 2,880 volts from a 90-volt battery. For other voltages, the rotor would be divided into a different number of equal parts.

Since the first few capacitors in the sequence usually operate at low voltage, they can be electrolytics. Paper or mica units are needed for the last few capacitors where the voltage exceeds 400 volts.

The principle outlined here can be applied to any source of low d-c



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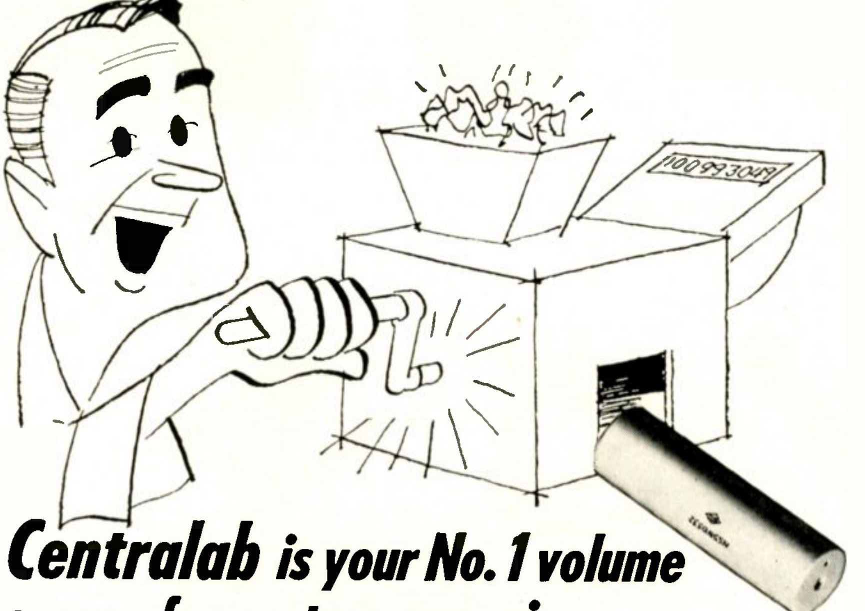

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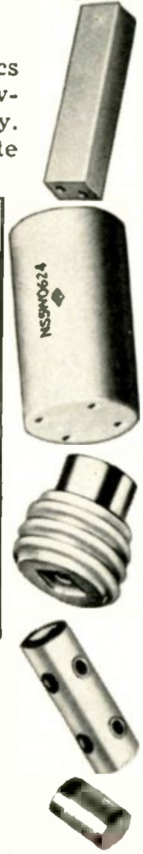
Power Factor (at 1 Megacycle)	.0012	.0048	.0014	.0090
Loss Factor (at 1 Megacycle)	.0069	.0299	.0126	.0535
Dielectric Strength (Volts per Mil)	265	228	210	260
Coefficient of Linear Expansion:				
20-200° C.	7.0×10^{-6}	2.1×10^{-6}	3.8×10^{-6}	4.6×10^{-6}
20-400° C.	7.4×10^{-6}	2.7×10^{-6}	4.3×10^{-6}	5.1×10^{-6}
20-600° C.	7.9×10^{-6}	3.1×10^{-6}	4.7×10^{-6}	5.7×10^{-6}
Moisture Absorption (%)	0-0.010	0-0.010	0-0.010	0-0.010
Apparent Specific Gravity	2.69	2.65	3.68	2.53
Modulus of Rupture (lbs/sq. in.)	19,000	17,000	20,000	13,300
Compressive Strength (lbs/sq. in.)	70,000	95,000	82,200	71,400
Impact Strength (ft. lbs/sq. in.)	1.95	1.80	2.21	1.55



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voltage where it is desired to boost this voltage for metering purposes or to obtain high-voltage discharges.

TV Avalanches

A SWEDISH ENGINEER making a four-nation tour arranged by the International Labor Organization, an agency associated with the United Nations, will study hazards of blasting operations in France, Germany, Canada and U.S.A.

Among problems to be investigated are those of premature detonation resulting from lightning and atmospheric electricity. Although Swedish experience with radio has shown no hazard from this source, precautions in the United States have been standardized for police, road maintenance and other cars using two-way radio.

While Sweden has no television broadcasting at present, authorities are anxious to ascertain the possible danger of such transmissions prior to establishment of television service.

According to a recent release from ILO, it has been suggested that radio signals from police cars can set off mountain avalanches.

Transistor Pulse Supply

By T. A. Prugh and J. W. Keller
Diamond Ordnance Fuze Laboratories
Washington, D. C.

SIMILAR to a single-transistor bistable switching circuit, a thyratron-type switch uses, instead of added base resistance a large choke coil. Similarly, a choke coil supplies the bias for the collector. This circuit operates as if the transistor is merely a switch in series with the two capacitors C_1 C_2 and the load resistance. When the switch is open, there is a difference in potential of about 20 volts between the emitter and collector. When the switch closes, this difference is transferred to the load.

The output pulse amplitude of this circuit is

$$V_o = (E_e - E_c) - Ir_{ec}$$

where

E_e = d-c bias on emitter
E_c = d-c bias on collector
I = peak current

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CONTACTS: Maximum of double pole rated at .25 amperes at 26.5 volts DC or 115 volts AC resistive

COIL: Sensitivity—nominal 1.0 watts, maximum 0.3 watts
Resistance—up to 1500 ohms
Voltage—up to 40 volts DC

TEMPERATURE: Minus 60° C to plus 125° C

VIBRATION: 10G up to 500 cycles

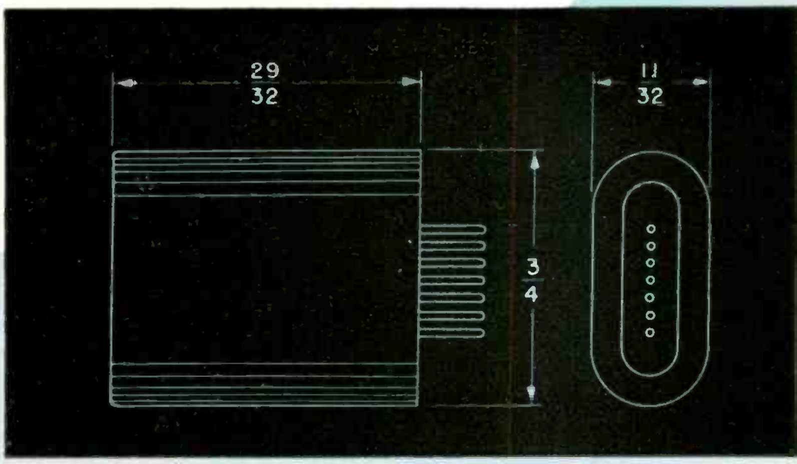
SHOCK: 50G plus (operating)

SPEED OF OPERATION: 1.5 millisecond at nominal voltage direct from battery supply and 1 millisecond with series resistance

ALTITUDE: 70,000 feet or 1.3 inches of mercury

TERMINAL TYPES: Printed circuit, solder terminals and plug-in

CAPACITY: N. O. contact to case 0.85 mmf



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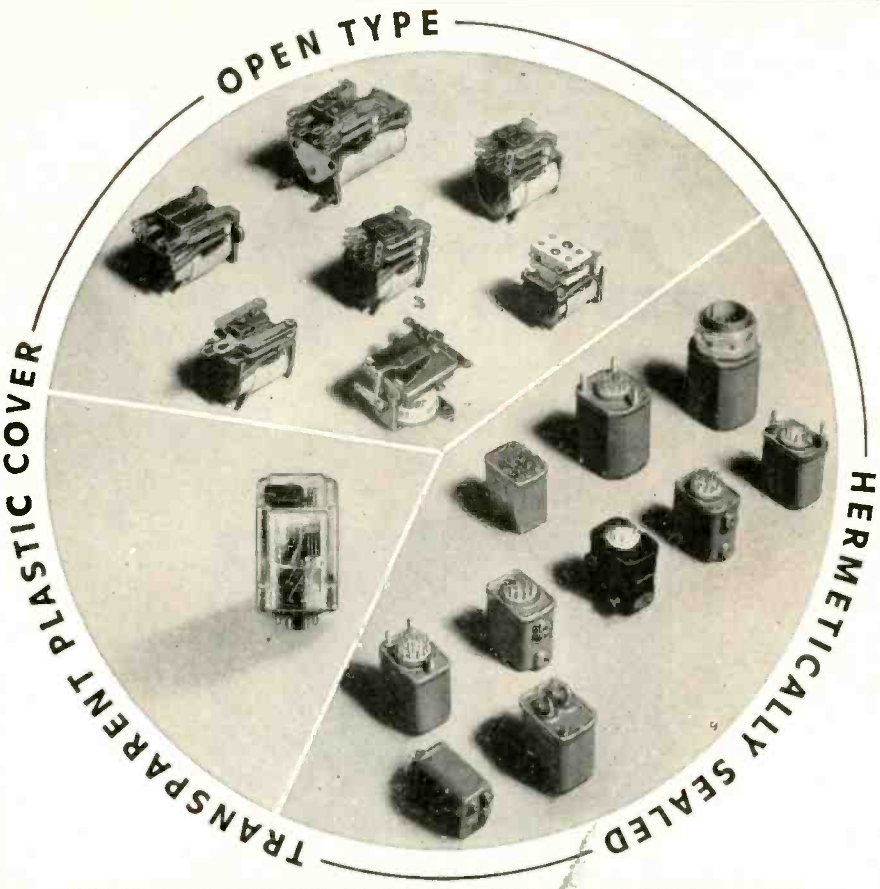

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r_{ec} = internal resistance from emitter to collector

The pulse time constant if the choke coils are large is

$$T = (R_L + r_{ec})\ (C_1C_2/C_1 + C_2)$$

The resistance r_{ec} encountered via the emitter and collector, is dependent upon the current amplitude in the same way as the forward resistance of a diode. Consequently the internal impedance of this circuit becomes quite low for small load resistances. For a peak current of 7 amperes, r_{ec} has been observed to be less than 5 ohms.

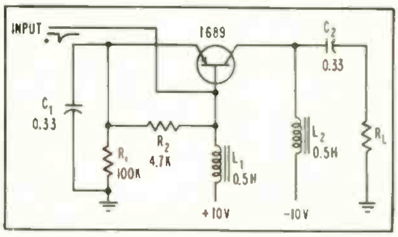
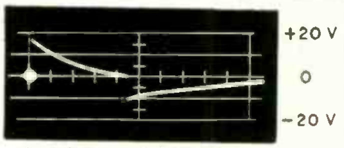


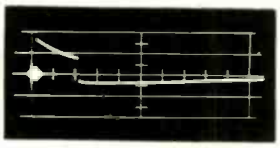
FIG. 1—Thyratron-type switch using transistor acts to break circuit in series with two capacitors and load resistance

Figure 2A shows the output pulse when L_1 and L_2 are large. It exhibits the simple *RC* decay where the peak voltage is the supply voltage minus the internal drop.

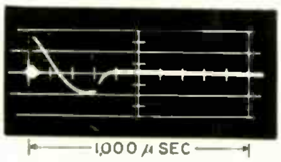
If L_1 is chosen smaller than normal the simple *RC* decay is interrupted by premature cutoff of the switch as shown in Fig. 2B and only part of the total pulse is avail-



L_1 NORMAL, L_2 NORMAL
(A)



L_1 LOW, L_2 NORMAL
(B)



L_1 NORMAL, L_2 LOW
(C)

FIG. 2—Output pulse shape determined by suitable values of inductance

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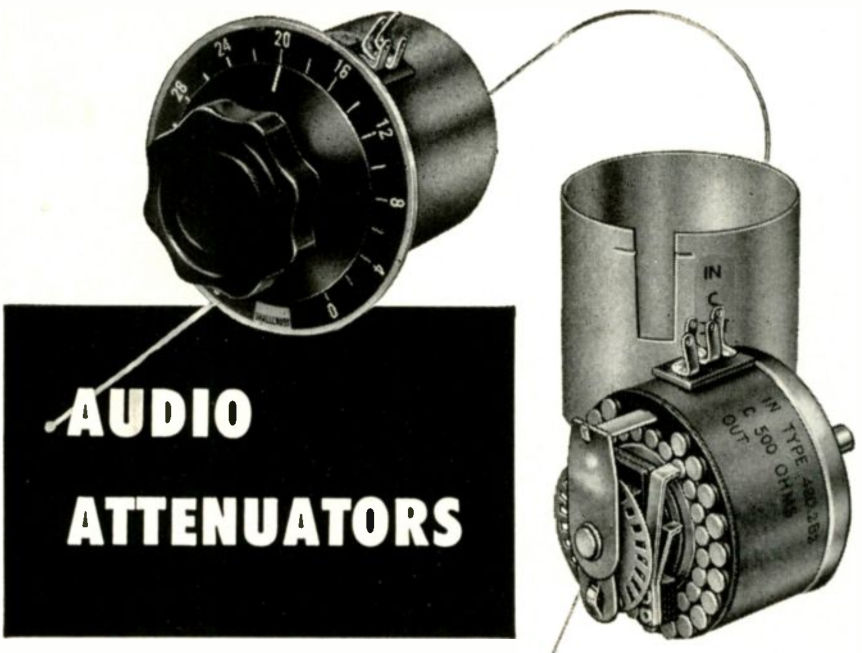

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able. The size of this inductance is dictated by the largest R_L encountered.

If L_2 is chosen too small, the output pulse takes on the flavor of an *LC* rather than an *RC* decay as seen in Fig. 2C. Similarly, the size of L_2 must be selected on the basis of the largest load resistance encountered. Inductances in the neighborhood of one-half henry are adequate if 1,000 ohms is the maximum load resistance. Of course other pulse shapes may be desired in which case L_1 and L_2 would be chosen differently.

Two different methods of triggering this switch have been used. A negative pulse can be applied to the base with instant triggering action, or the two resistances R_1 and R_2, that provide the small negative bias for the emitter can be removed and this bias supplied by the input circuit. Triggering action is then accomplished when the level of bias is raised to a potential close to the base potential.

The single stage described has an adequate performance in the temperature range of interest except for its peak amplitude, which is too small. With supply voltages of -10 and $+10$, the output is limited to about 18 volts. A peak voltage of several times the supply voltage is needed.

This large amplitude can be obtained by simply connecting three of the stages in series as shown in Fig. 3. Only the first stage need be triggered and this triggering can be done as already mentioned for a single stage. Subsequent stages are triggered by the positive pulse on their emitters received from the preceding stages.

The behavior of output-pulse amplitude as a function of temperature is shown in Fig. 4.

The output voltage of the three stages is

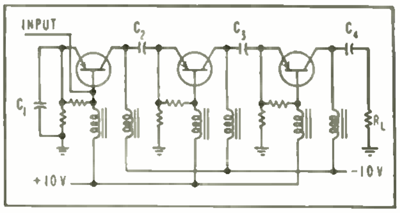
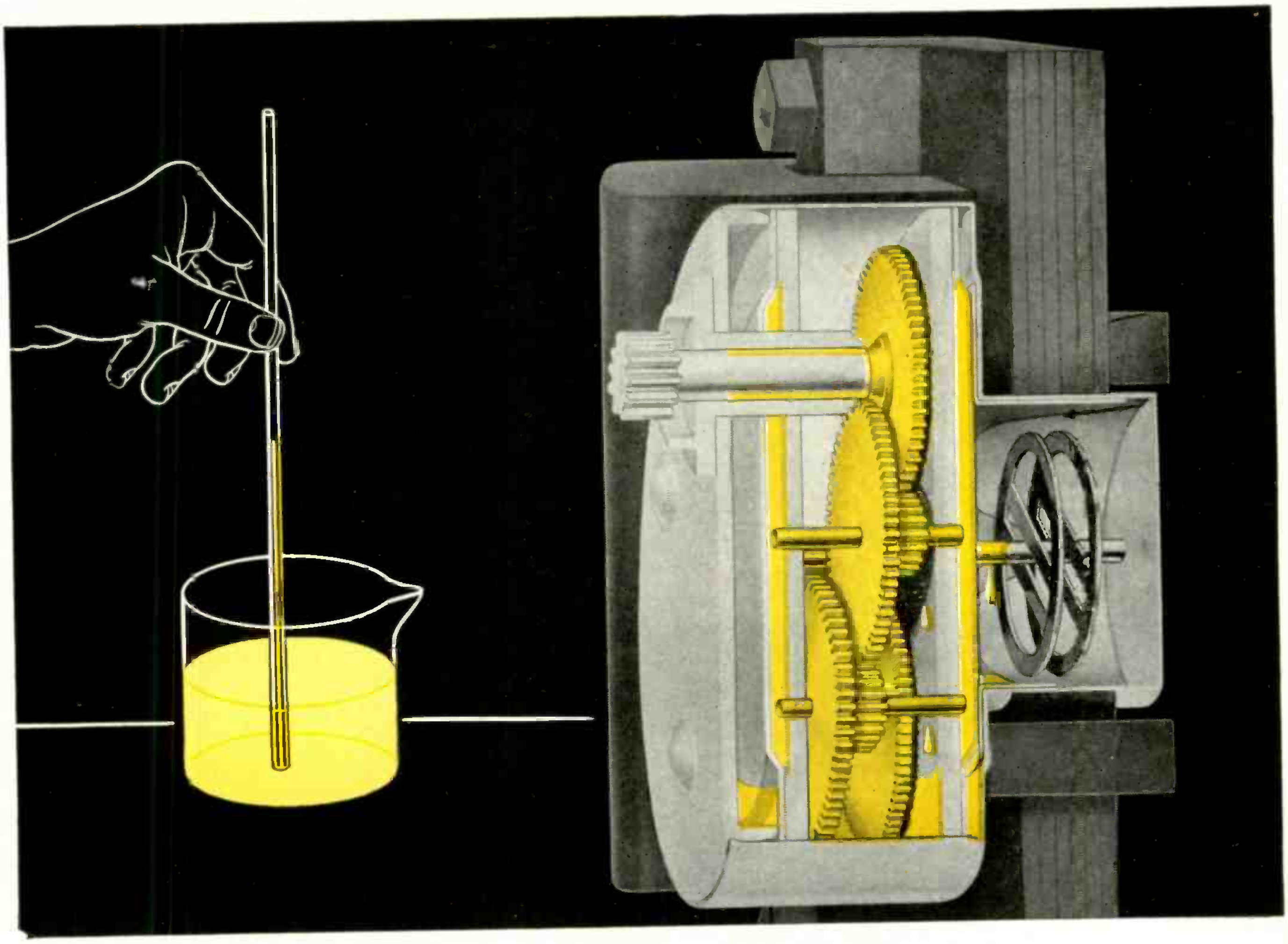


FIG. 3—Multiple-stage circuit furnishing output pulse almost three times the supply voltage amplitude



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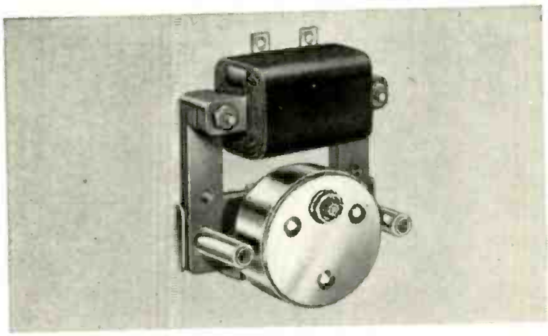

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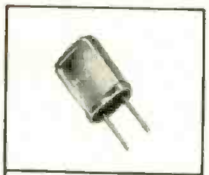

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$$V_o = 3(E_e - E_c) - 3Ir_{ec}$$

and the decay time is

$$T = (R_L + 3r_{ec}) \times \frac{C_1C_2C_3C_4}{C_1C_2C_3 + C_2C_3C_4 + C_3C_4C_1 + C_4C_1C_2}$$

Transistor Performance

The application of the switch circuit just discussed occasionally calls for current amplitudes considerably above known ratings of the transistors. For this reason it was felt that some qualitative data should be obtained on the capabilities of transistors in this circuit. The collector characteristic curves of Fig. 5 show the gradual and typical deterioration of a type 1689 transistor used in a two-stage switch delivering a 40-volt pulse across a 47-ohm resistor. The peak current is about 0.8 amp. The circuit is still in fairly good working order after 8,000 pulses although it is clear that alpha and r_e are decreasing and I_{co} is increasing. The point of unsatisfactory operation has not been determined with the small sample of about 15 used in this ex-

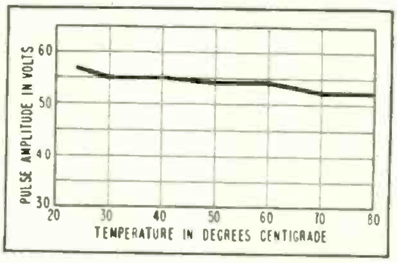

FIG. 4—Output pulse amplitude of three-stage circuit as function of temperaturo

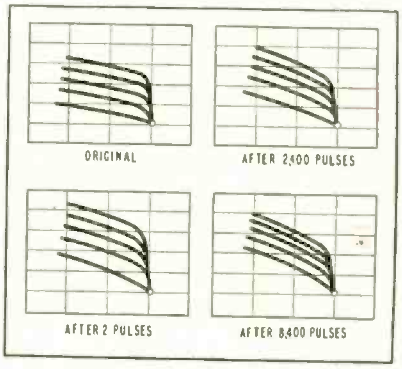

FIG. 5—Change in transistor collector characteristics due to various numbers of pulses

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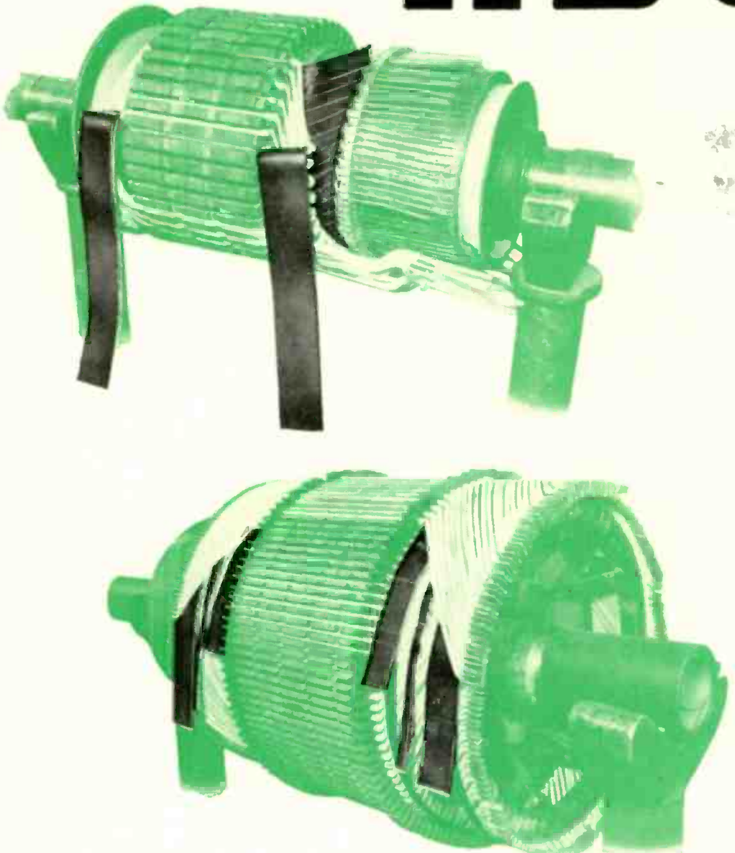

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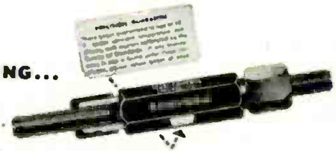

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periment. Often the end came rather suddenly with a complete collapse in alpha, which, incidentally was occasionally recoverable.

If the pulse amplitude is reduced to 0.4 amp, only a small percentage of transistors will be affected by pulses numbering in the million. If reduced to 0.2 amp no failure of a transistor has been recorded. In terms of load for a three stage switch, if the load resistance is greater than 250 ohms, a long and useful life can be expected from the average 1689 and at least 5 pulses could be expected into 10 or 20 ohms.

Credit is due E. Harrison who obtained most of the data for this paper.

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ABSORPTION CURVES, diffuse reflectance curves and emission spectra from various sources can be studied with a cathode-ray display spectrophotometer that scans and plots the interval from 400 to 700 millimicrons in 1/180 second at a repetition rate of 60 spectra per second.

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Figure 1 is a diagram of the scan-

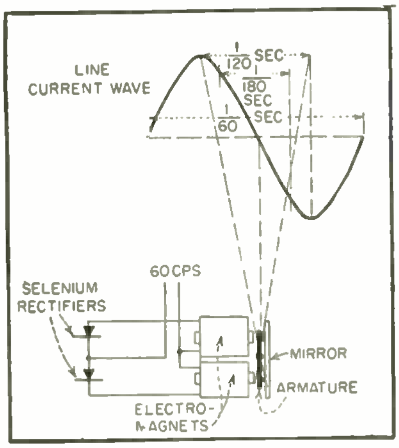
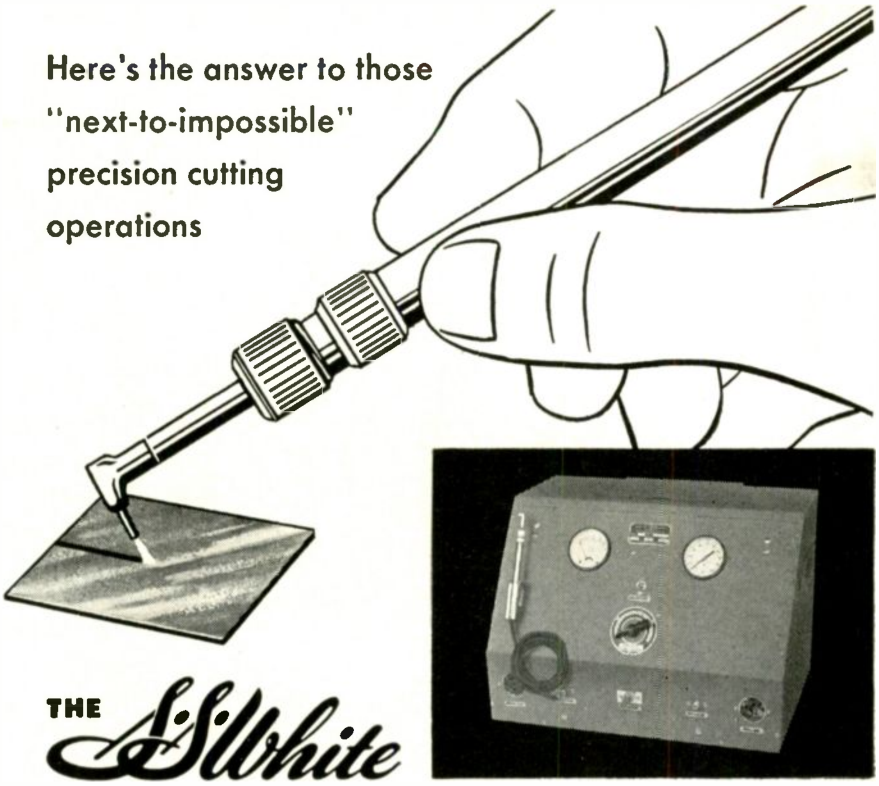


FIG. 1—Special magnetically deflected mirror and line current wave



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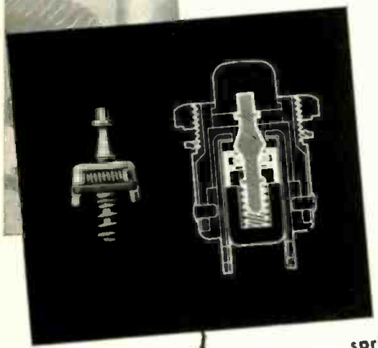
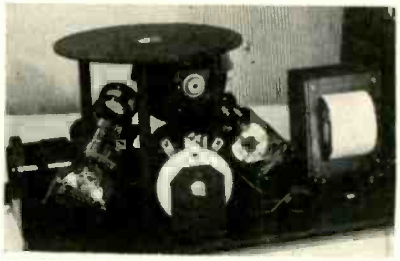


ning mirror. It consists of a soft iron armature pivoted at its center, which carries the mirror and a pair of electromagnets. Angular displacement of the mirror with respect to time is constant over a substantial portion of its swing. The rectifier arrangement allows one magnet to pull the mirror to one extreme position and energizes the other magnet during the subsequent half cycle. The mirror thus scans the spectrum over the exit slit twice per cycle. Motion in only one direction is used, however, to avoid hysteresis difficulties. Mirror amplitude is adjusted to scan the desired interval linearly during 1/180th of a second.



Reflectance illuminator unit

The pentagrid converter tube at lower left of Fig. 2 obtains a sine-wave signal from the mirror line. The network shifts this sine wave 90 deg so the potential wave applied to grid 3 agrees in phase with the current wave through the magnets and the instantaneous displacement of the mirror. Inverse feedback and plate saturation distort the portion of sine wave occurring during

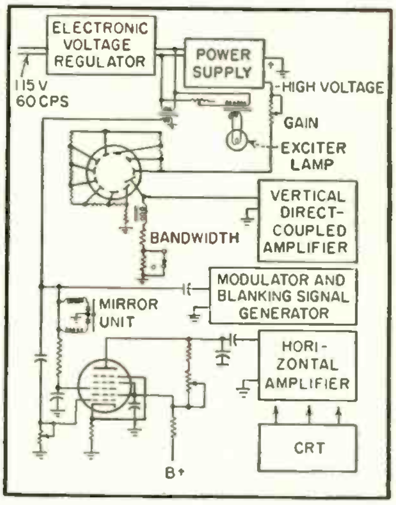

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FIG. 2—Simplified diagram shows interconnection of parts

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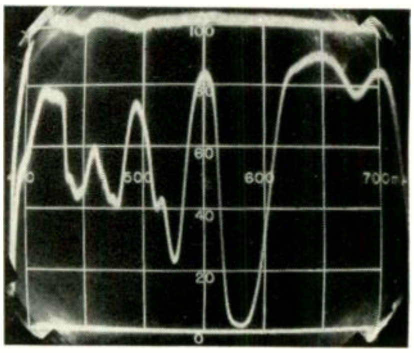
the useful sweep interval of the mirror to an approximation of the optical dispersion curve of the instrument.

A small correction is mixed with this through grid 1 and its network to obtain precise agreement between the potential-time curve of the waveshaper and the wavelength-displacement curve of the spectrometer. The scanning mirror, makes this possible since it interprets wavelength in terms of time. Waveshaper output is fed to the horizontal amplifier of the indicator and the cathode-ray tube spot is thus moved nonlinearly with respect to time such that the output of the detector, which is proportional to intensity, is plotted against a linear wavelength scale.

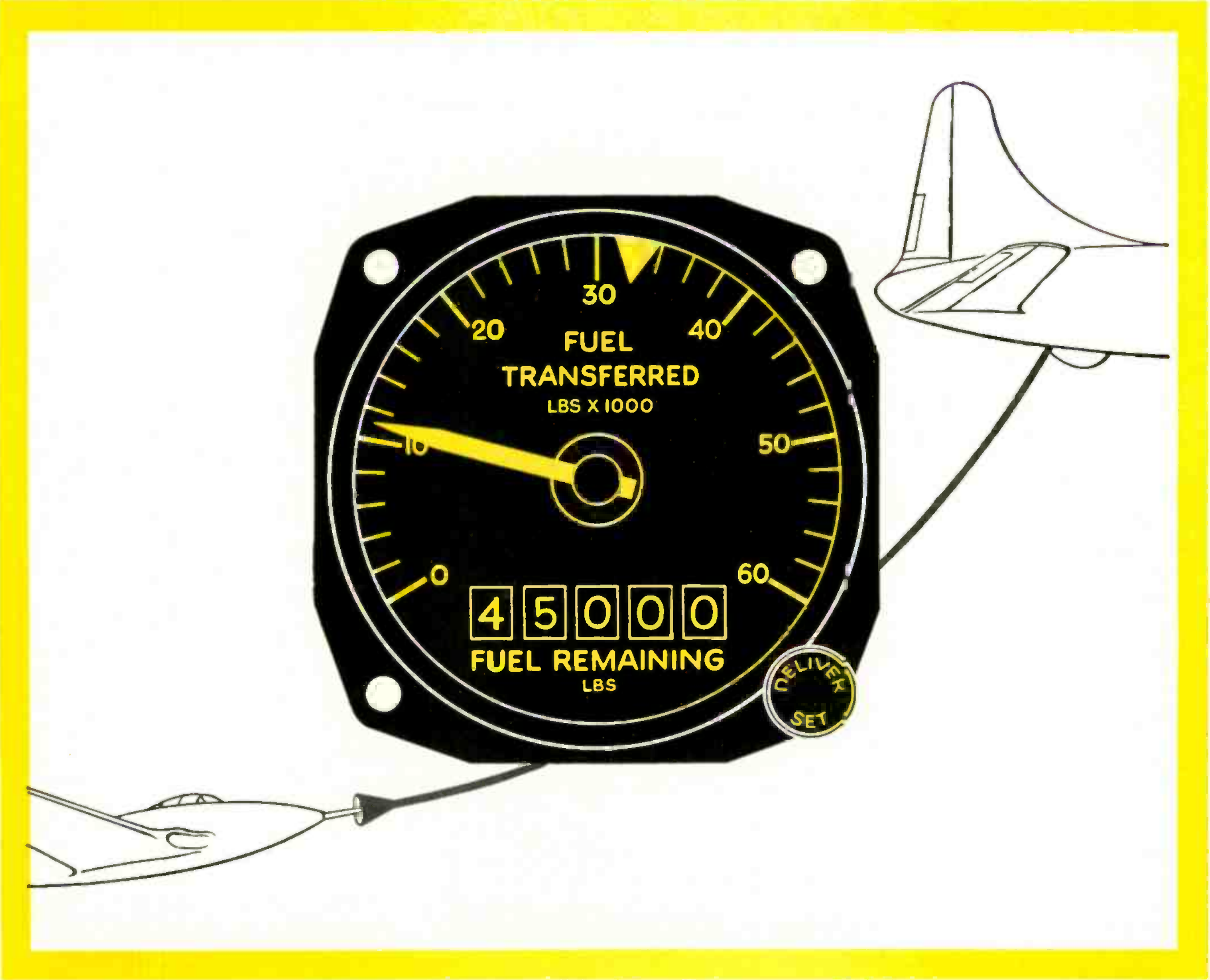
The detector output circuit constants are chosen to give a high-frequency cutoff determined by the length of time required to scan the spectral image of the entrance slit across the exit slit for any one wavelength. This works out to 50,000 cps for the 7-millimicron slit used in absorption work and 15,000 cps for the 20-millimicron slit used in reflectance work.



Oscillogram made with recording camera shows three traces. Sample curve is didymium filter

Direct-coupled amplifiers must be used to maintain the zero-light indication coincident with scale zero. The high-frequency limit is adjusted in the multiplier circuit to use minimum total bandwidth and assure maximum signal-to-noise ratio. The modulator and blanking generator develop a dual-purpose waveform from the same sine wave applied to the mirror and scanning-wave generator.

The first function is to blank the cathode-ray tube during the unused



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The gage face can be quickly cleared and re-set for subsequent refuelings. At the same time, total fuel remaining for transfer is constantly indicated.

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Every month, AVIEN produces over 10,000 major instrument components for the Aviation industry. They have been specified for more than fifty different aircraft models.

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portion of the total operating cycle. The second function is to increase the spot intensity as it moves across the screen with ever-increasing velocity so that the trace brightness will be reasonably constant over the entire scale. The net result of these interactions between optical, mechanical and electrical design is a plot of spectra that is rigorous within the reading accuracy of the instrument.

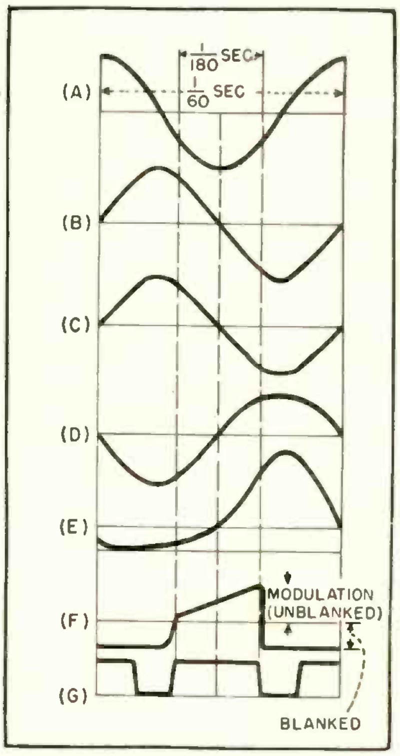
$\frac{1}{180}$ SEC
$\frac{1}{60}$ SEC
(A)
(B)
(C)
(D)
(E)
(F)
(G)
MODULATION (UNBLANKED)
BLANKED

FIG. 3—Waveforms described in text

Figure 3 gives the waveform relationships on a one-cycle time base. The upper curve is the line potential wave. The center third of the interval is the active time of the instrument. The second waveform (B) is the line-current wave for the mirror magnets, −90 deg out of phase. The next (C) is the displacement curve of the mirror with respect to the same time base. The next waveform (D) is the phase-shifted potential wave applied to the scanning waveshaper input, which comes out as the horizontal scanning wave (E) and has the same shape as the instrument dispersion curve.

The sixth wave (F) is the blanker output, showing how the indicator is cut off during the unused portion of the cycle and how

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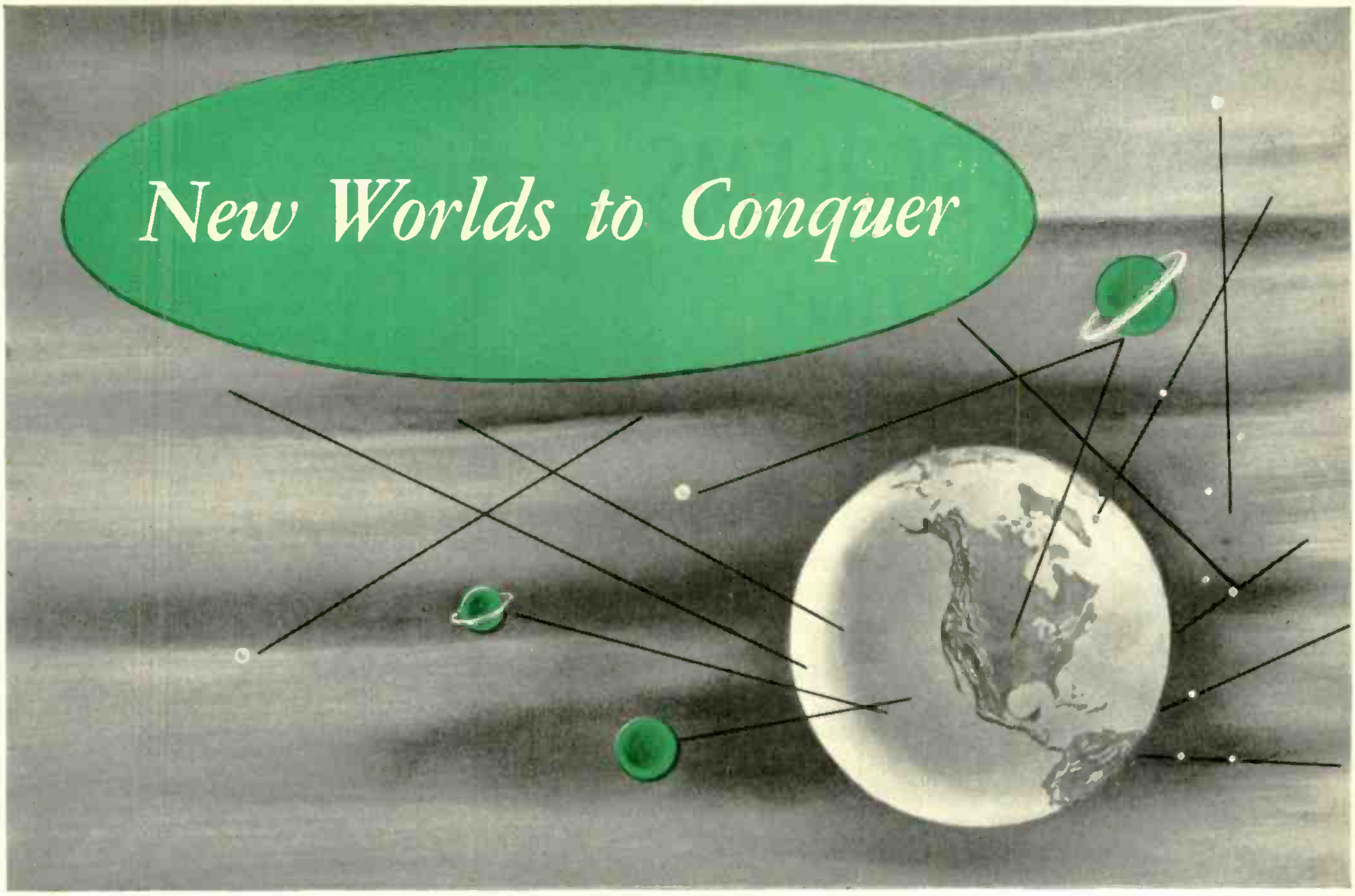

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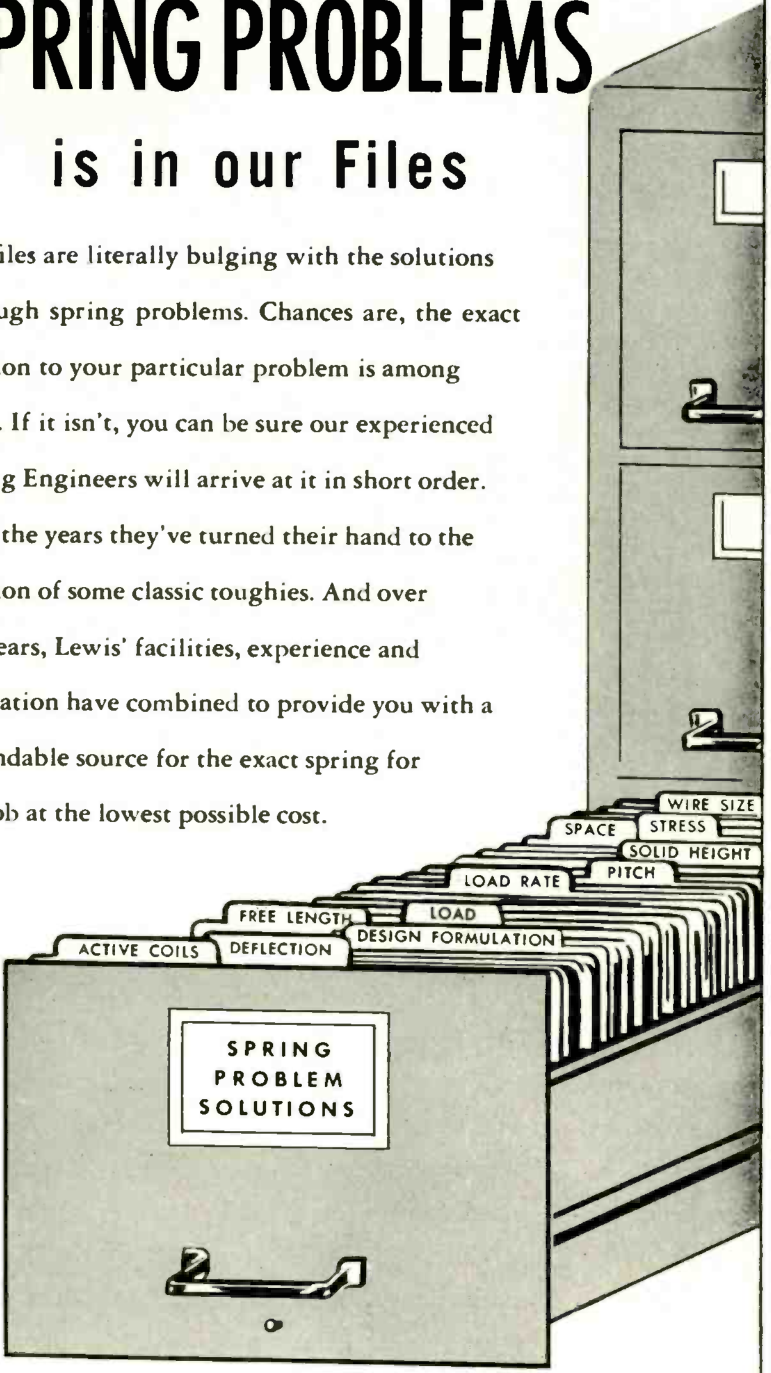

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the spot intensity is increased roughly with spot velocity. The last waveform (G) shows the output wave of the multiplier when no sample is in the beam.

The reflectance illuminator is shown in the photograph. The three exciter lamps and their lens assemblies are arranged at 120 degrees from each other in the horizontal plane and illuminate the pickup area at 45 degrees in the vertical plane. Energy diffusely reflected from a surface placed over the pickup area is reflected by the first surface mirror through the collector at the left and into the other unit.

The oscillogram was made with a recording camera. It shows three traces,—the full-scale trace with nothing in the beam, the sample curve (in this case a didymium filter) and the zero trace with the beam shuttered. The whole process requires about a second. The instrument plots its own white-light error and records it for reference.

Resolving power of the instrument varies with wavelength since the slit widths are constant through the scanning cycle. The average for transmission work is about 6 millimicrons and for reflectance about 20 millimicrons. Accuracy is one percent of full scale.

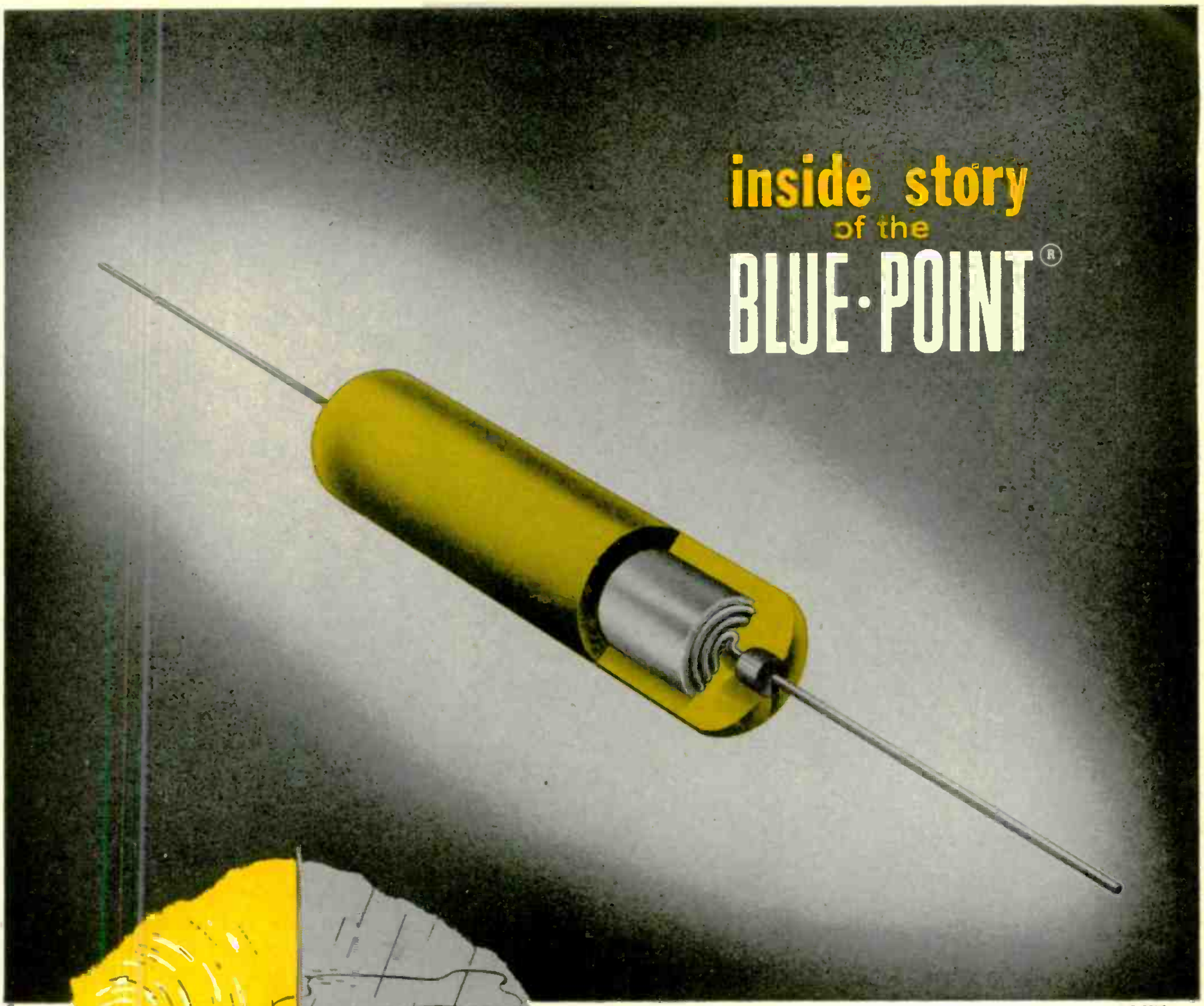
Information concerning the instrument has been furnished by American Optical Co., Instrument Division, Buffalo, N. Y. and is similar in some respects to that presented by R. C. Beitz in the *Journal of the Optical Society of America.*

Electronic Juggler

By Charles Whaley and Sidney Godet

Reeves Instrument Corp.
Subsidiary of Claude Neon Inc.
New York, N. Y.

The electronic juggler is an application of electroservomechanisms simulating the human one-finger broomstick balancing act. The broomstick is essentially an inverted pendulum swinging freely to and fro under the combined action of gravity and momentum. In the electronic unit the broomstick is a 3-foot brass tube with a light source and batteries located in a container on the upper end. The lower end of the tube, a pivot



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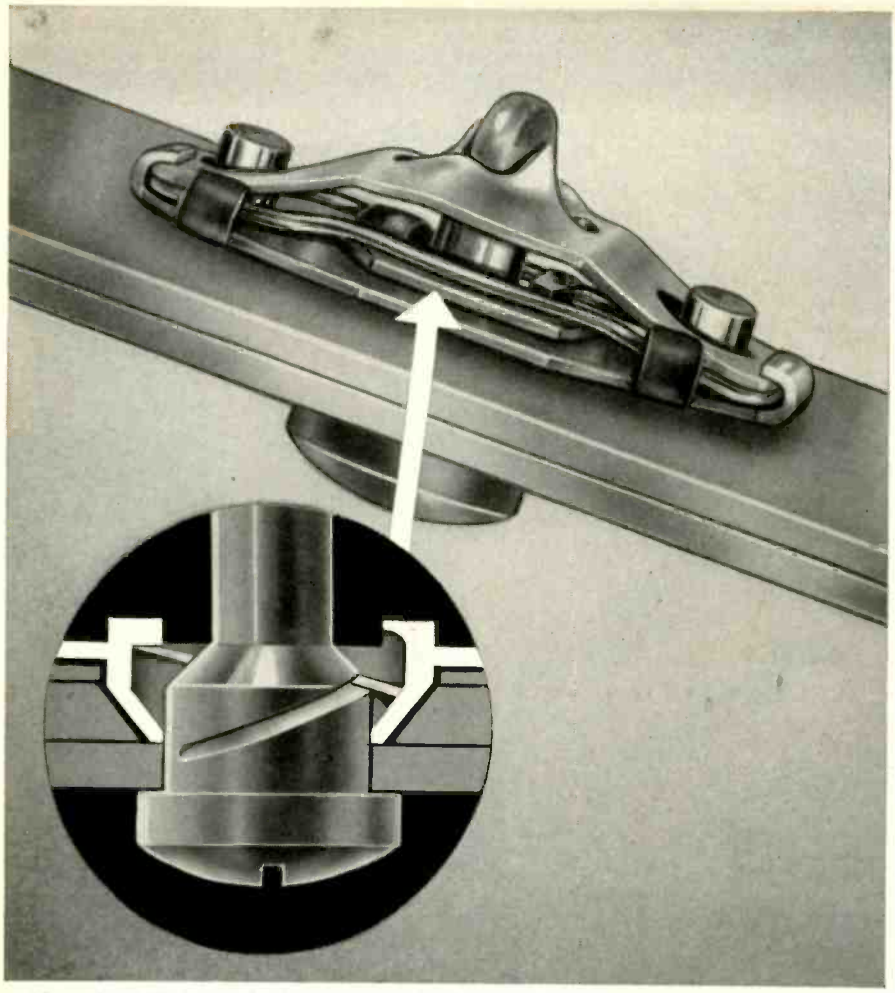

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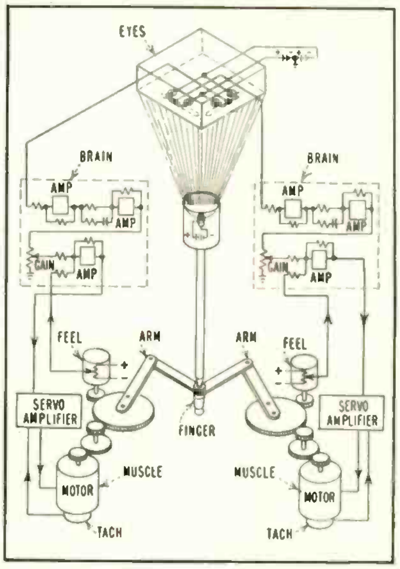

Juggler duplicates human act of balancing stick on tip of finger. Labeling shows human functions duplicated by servo system

point, sits on a finger as shown in the diagram. The finger is on a ball bearing riding on a glass plate, thereby minimizing friction. The finger is cupped on top to support the broomstick.

Light falls on two sets of phototubes located in a frame 9 inches above the end of the stick. The phototubes provide x and y (rectangular co-ordinate) position error data.

The error from the phototubes due to the falling of the broomstick is amplified, shaped and summed in with the feel error from a potentiometer connected to the servo drive by means of a system of d-c amplifiers and R-C networks.

A servo amplifier converts the d-c signals into a-c and provides power to drive a 10-watt two-phase servomotor. The motor drives a system of gears and linkages that positions the finger in response to the phototube and feel errors. A d-c tachometer provides a stabilization signal to the servo amplifier.

The approximate equation of the broomstick pendulum in a single plane is

$$\frac{d^2u}{dt^2} = \frac{g}{l}(u - v) \qquad (1)$$

where u = position of top of broomstick
v = position of bottom of broomstick
g = acceleration of gravity
l = length of broomstick

The control system performance

NEW VSWR TEST SET

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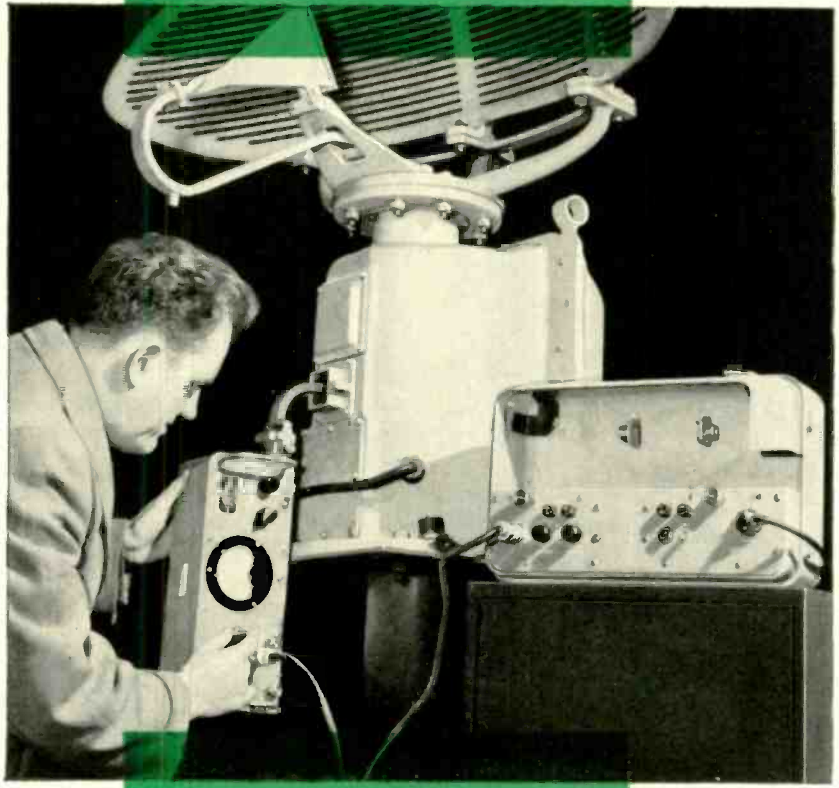

- Now available is the Sperry Microline* Model 539, VSWR Field Test Set, designed for accurate measurement of the voltage standing-wave ratio of X-band radar equipment during installation, maintenance and repair. This compact portable test set is also ideal for use in production and laboratory testing.
- Model 539 is a direct-reading reflectometer-type instrument which consists of a klystron oscillator, high directivity directional coupler, detector, amplifier and indicator, power supply and modulator. Calibration is accomplished with a reference mis-match.
- The simplicity of adjustment and operation of the test set make it extremely useful for accurate measurements over the entire range. It is particularly useful in adjusting a standing-wave ratio since the meter gives a continuous indication. Indicator unit can be easily connected to the equipment to be tested with a thumbscrew-operated clamp.
- This test set is approved by the military as the AN/UPM-12 meeting all the requirements of Specification MIL-T-945A.

*T.M. REG. U.S. PAT. OFF.

For convenience in field work, the microwave indicator unit can be easily removed from carrying case.

SPECIFICATIONS

VSWR Ranges	1.05–1.3±5% 1.3–2.0±5% 2.0–3.0±10% 3.0–10.0 uncalibrated
Freq. Range	8.5–9.6 kmc
Waveguide Connection	RG52/U (1 x ½ waveguide) or RG51/U (1¼ x ⅝ waveguide) through accessory adapter
Dimensions	Length 19¼ in. Width 12 in. Height 10¼ in.
Weight	35 lbs.
Power Requirements	105–125 volts 50–1000 cycles 75 watts

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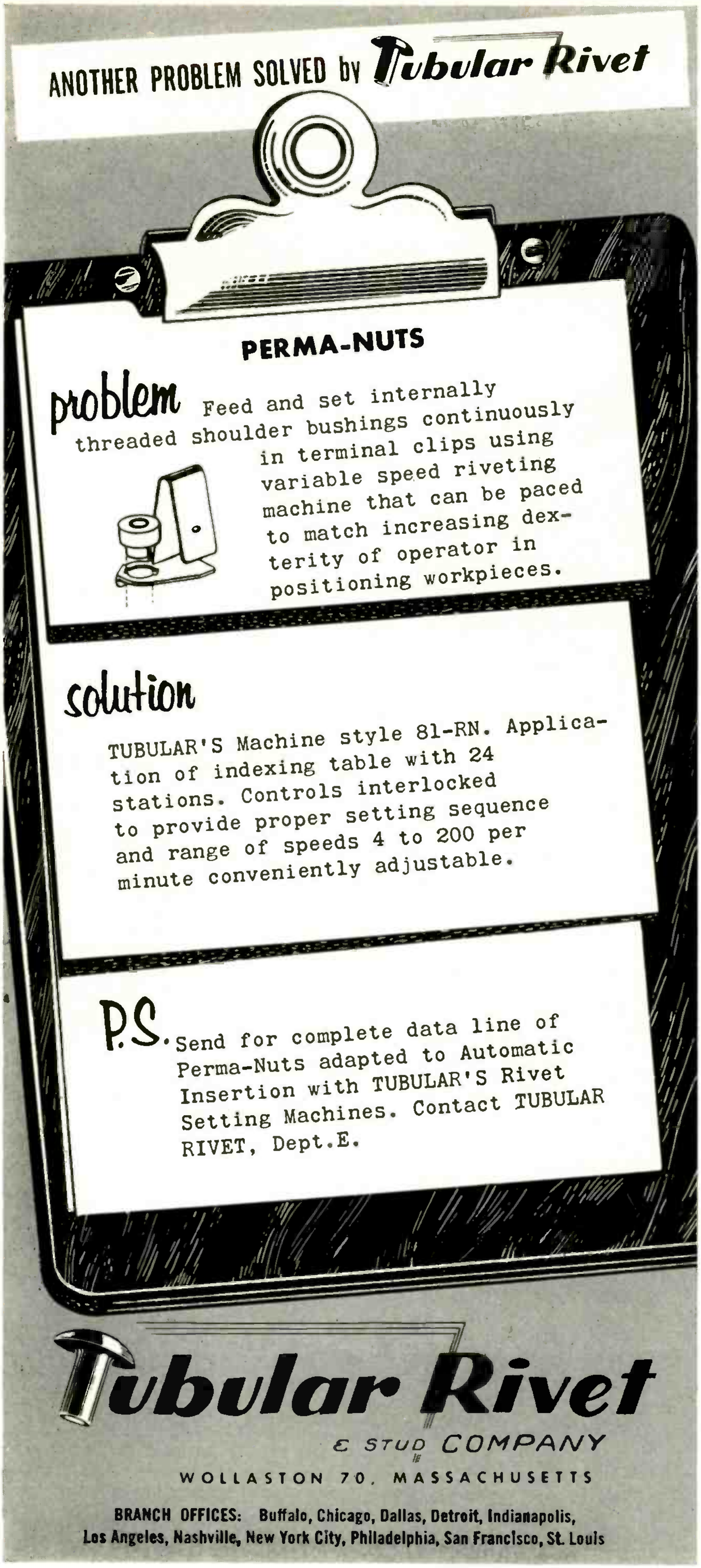

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is given by

$$v = (l + a)u + b\frac{du}{dt} \qquad (2)$$

where *a* and *b* are constants, and Eq. 2 is instrumented for each of the two control planes by the brain, which is a standard computer unit. Combination of Eq. 1 and Eq. 2 gives the system performance equation

$$\frac{d^2u}{dt^2} + \left(\frac{bg}{l}\right)\frac{du}{dt} + \left(\frac{ag}{l}\right)u = 0 \qquad (3)$$

Although Eq. 1 gives rise to instability (broomstick falls over), Eq. 3 gives rise to stable operation, where *a* controls the restoring force, and *b* controls the system damping.

The electronic juggler is stable in operation. In holding the light source in a practically fixed position, the finger moves about ±¼ inch from its equilibrium position. If the broomstick is manually rotated in either direction, it sustains the rotation.

The system recovers satisfactorily from momentary interruption of the light beam. The system is critical to any restriction and reacts violently if constrained. No dynamic measurements have been made, but it is apparent that the electronic juggler is a much better performer than a person attempting to balance a pole on his finger.

Graphical Solution of Power Transfer Problems

By A. C. Macpherson
National Bureau of Standards
Washington, D. C.

USE OF A MODIFIED Smith chart permits a graphical solution to the problem of power transfer from a generator of complex reflection coefficient S_G to a load of complex reflection coefficient S_L. In this method it is assumed that the waveguide or coaxial outputs of the generator and load have identical cross sections and that only the dominant mode is present at these outputs. If the generator is matched ($S_G = 0$) the power delivered is proportional to $1 - |S_L|^2$. When the generator is not matched, however, the power delivered is proportional to $(1 - |S_L|^2)\,R$, where R is a real

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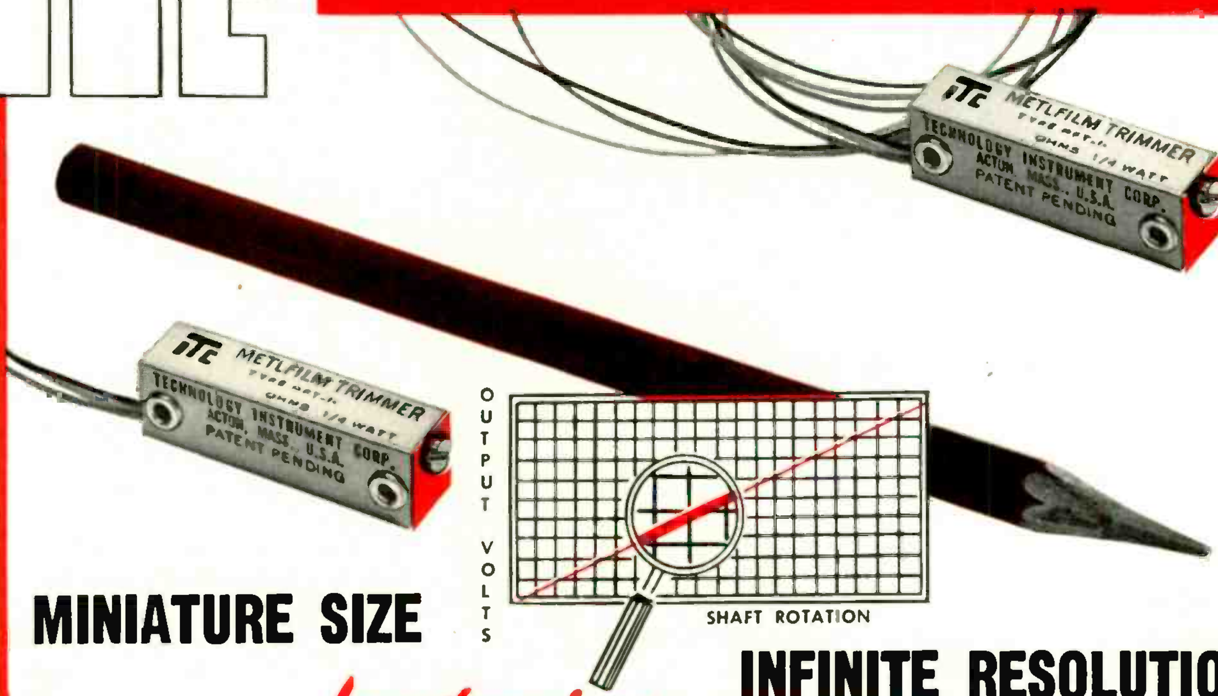

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SPECIFICATIONS

Electrical

Resistance Range: 50-25,000 ohms

Total Resistance Tolerance: ± 10%

Independent Linearity: ± 5% of total resistance

Resolution: Infinite

Power Rating: 1/2 watt at 40°C.; 1/4 watt at 125°C. per JAN-R-19 test specification.

Ambient Temperature Range: − 65°C to + 125°C.

Temperature Coefficient of Resistance Element: .000250/°C (nominal)

Dielectric Test: 500 volts DC between all leads, shaft and mounting eyelets for 5 seconds without flashover or breakdown.

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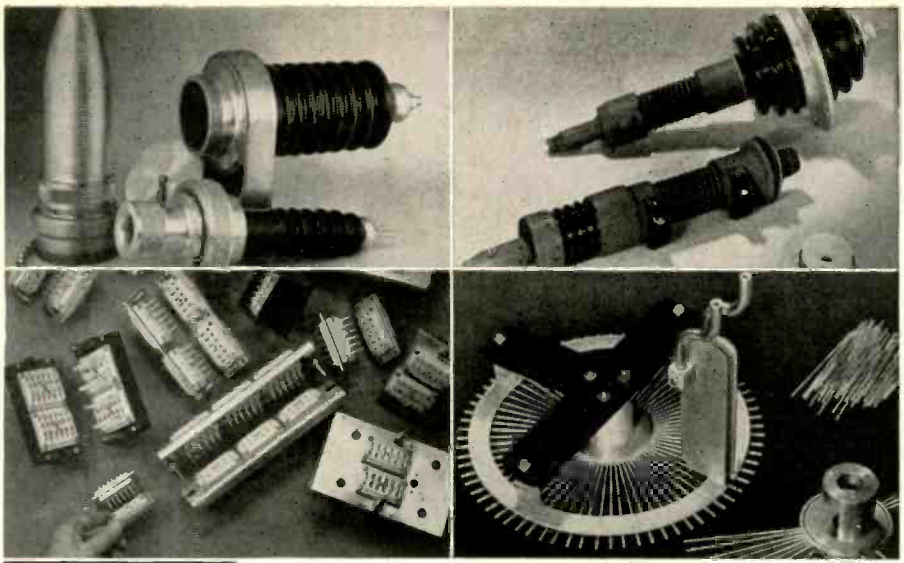

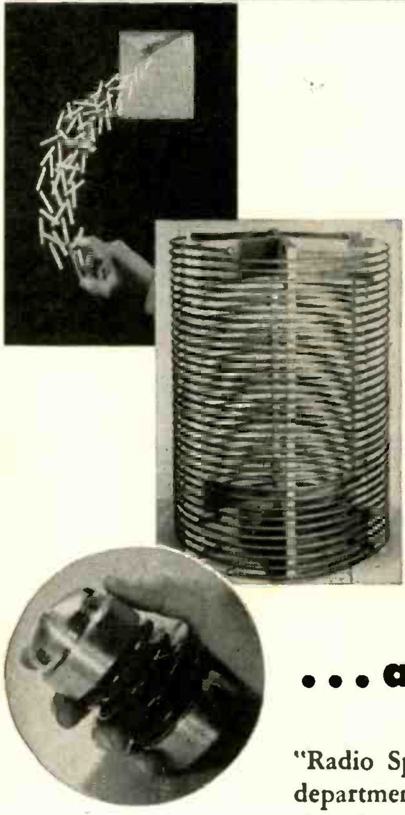

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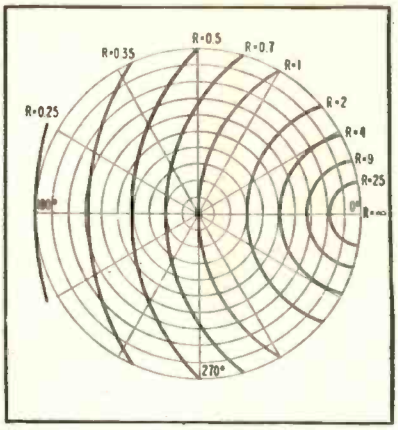

Smith chart for graphical solution of power transfer problems

number which depends on $S = S_0 S_L$. The accompanying modified Smith chart gives a graphical solution for R. The vector S is drawn on the chart with its origin at the center. The terminus of S will then lie on the proper contour of constant R and can be read off. For example if $S = 0.8 \exp(j\,\pi/6)$, $R = 4$

The chart is particularly useful in studying variation of power delivered to a terminating impedance through a lossless line the length of which is varied. In this case the

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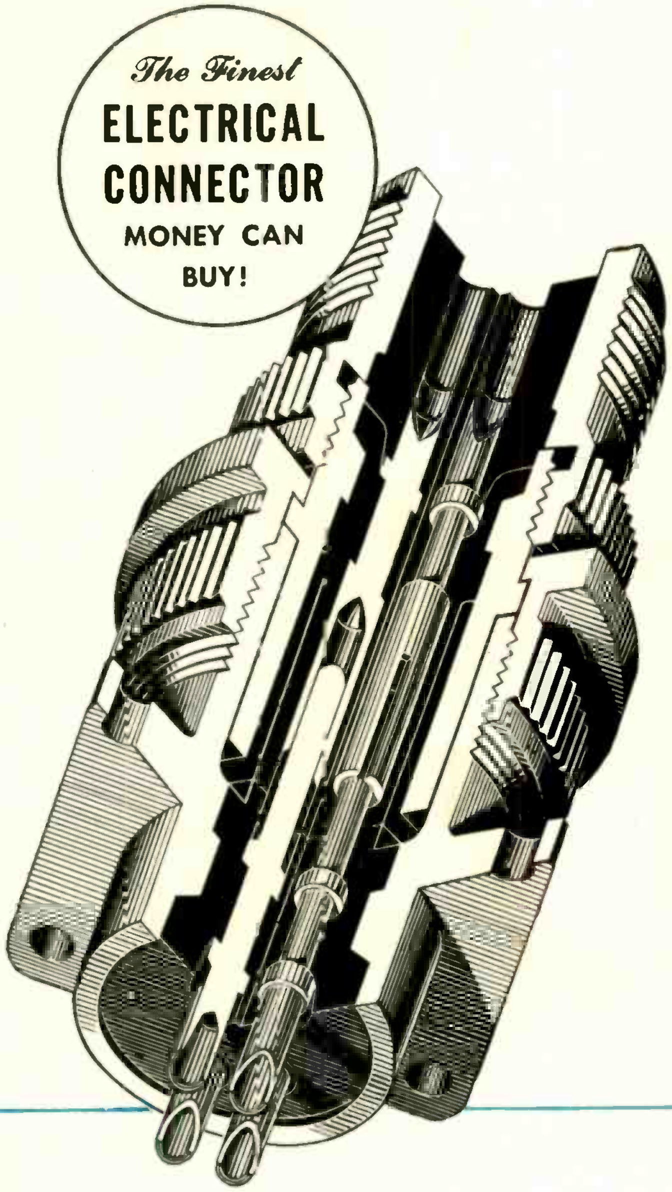

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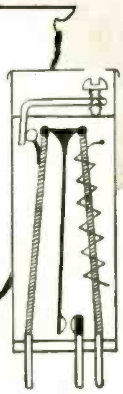

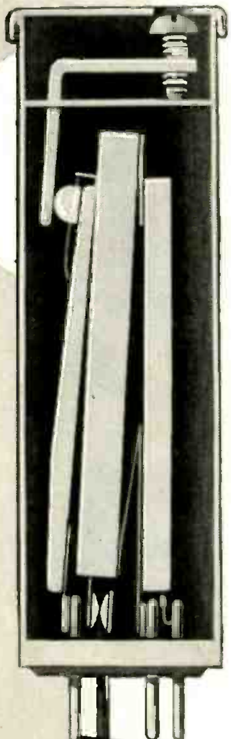

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factor $1 - |S_L|^2$ is constant and can be ignored.

For example, determine variation in power transferred from a generator of $|S_G| = 0.6$ to a load of $|S_L| = 0.5$ as the line length between the generator and load is varied. Varying the line length is equivalent to varying the phase of S_L which is in turn equivalent to varying the phase of S. Since $|S| = |S_L|\,|S_G| = 0.3$, we consider a vector of length 0.3 whose phase varies from 0 to 360 degrees. By noting the R contours which the terminus of the vector touches as it rotates we obtain the variation of power transfer. In this case maximum power is proportional to approximately $2\ (1 - |S_L|^2)$ and the minimum is proportional to approximately $0.6\ (1 - |S_L|^2)$. For minimum variation, it is important to have $|S|$ as small as possible.

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The battery produces up to 400 volts at relatively low current values. Optimum useful life of 18

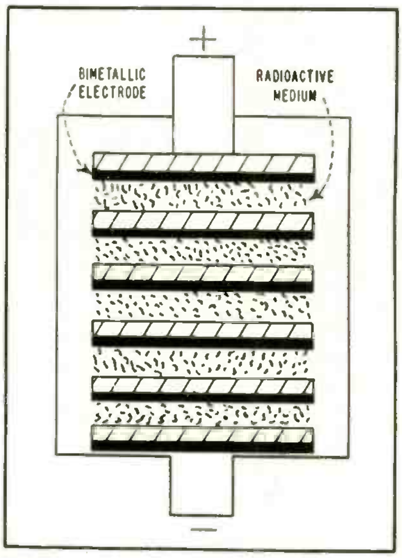

FIG. 1—Atomic battery developed for the U. S. Signal Corps provides up to 400 volts at 0.01 to 1.0 microwatt of power

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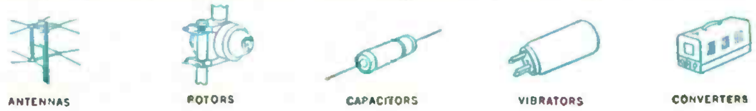

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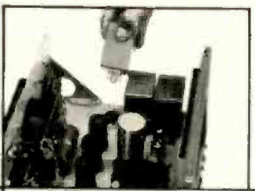

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By Frank C. Alexander, Jr.
Gulf Research and Devolpment Co.
Pittsburgh, Pa.

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The basic circuit developed is shown in the circuit diagram. The Clapp-oscillator configuration provides a stable carrier frequency. The prf is controlled by C_5 and duty cycle is adjusted with R_D.

The 1N91 diode clamps the emitter negative swing to ground and charges timing capacitor C_5, which cuts off the transistor. Discharge occurs slowly through small

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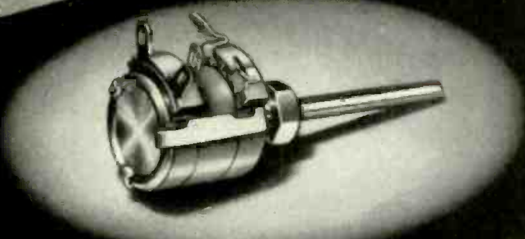

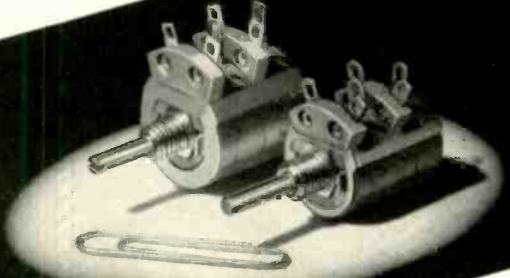

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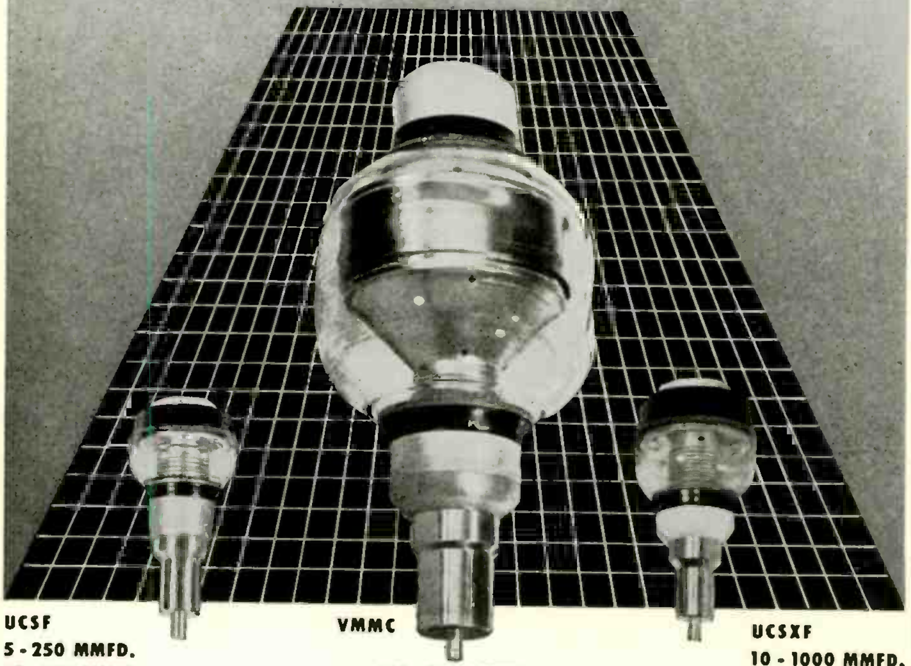

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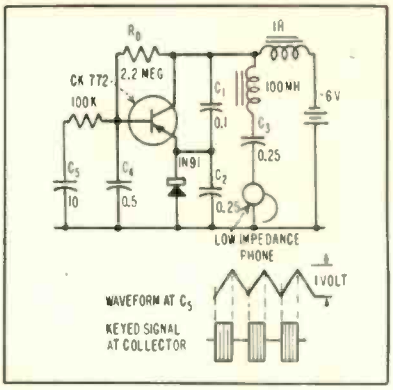

Transistor oscillator provides prf from 100 per second up to 2 per minute

cutoff conductance until oscillation conditions again obtain. The cycle then repeats.

The inductors have Q's of 30 at 1 kc. They are wound on small Ferroxcube pot cores.

Carrier frequencies of 2 megacycles have been achieved with this circuit using TI-201 *npn* transistors. Pulse repetition frequency is adjustable from 100 per second to 2 per minute by varying C_5. To use *npn* transistors the polarity of the battery, diode and electrolytic capacitor should be reversed.

REFERENCES

(1) R. L. Wallace, Jr., and W. J. Pietenpol, Some Circuit Properties and Applications of n-p-n Transistors, *Proc IRE*. 39, p 753, July 1951.

(2) Peter G. Sulzer, Junction Transistor Circuit Applications, ELECTRONICS, 26, No. 8, p 171, Aug. 1953.

Phototransistor Card Reader

USING PHOTOTRANSISTORS to detect markings, a 118-channel card reader is now in operation for automatic handling of toll telephone calls. Using the phototransistor in conjunction with a transistor amplifier as shown in the diagram the unit has made 28,000,000 laboratory test readings with negligible failures.

The phototransistor is illuminated by a light beam modulated at 400 cps when a card punch hole passes over the reader. The light acts as the emitter of the phototransistor, which has a collector impedance of about 10,000 ohms. This impedance is reduced to approximately 3,000 ohms by the illumination. The a-c signal from the photo-

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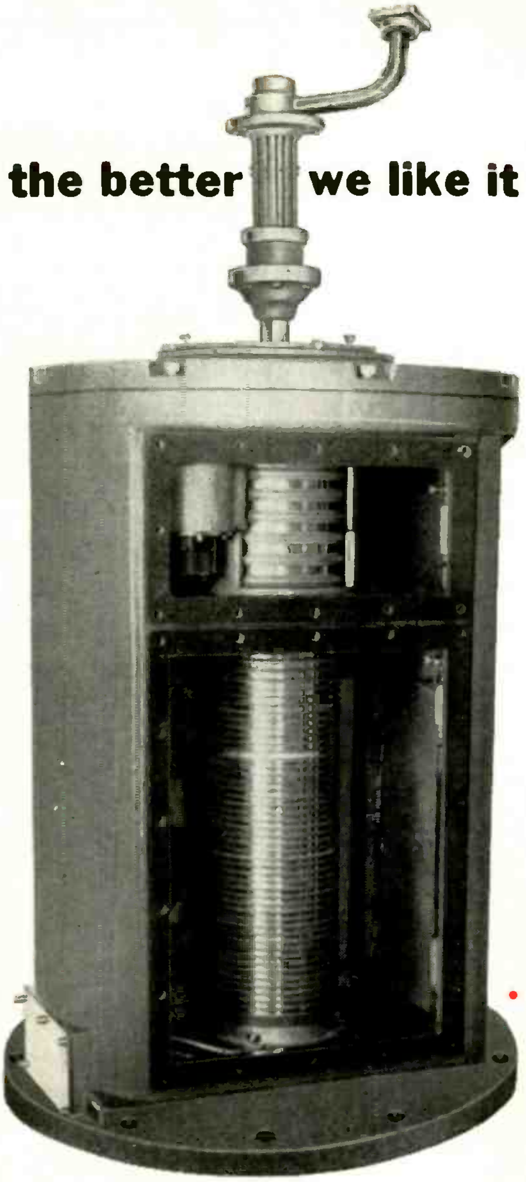

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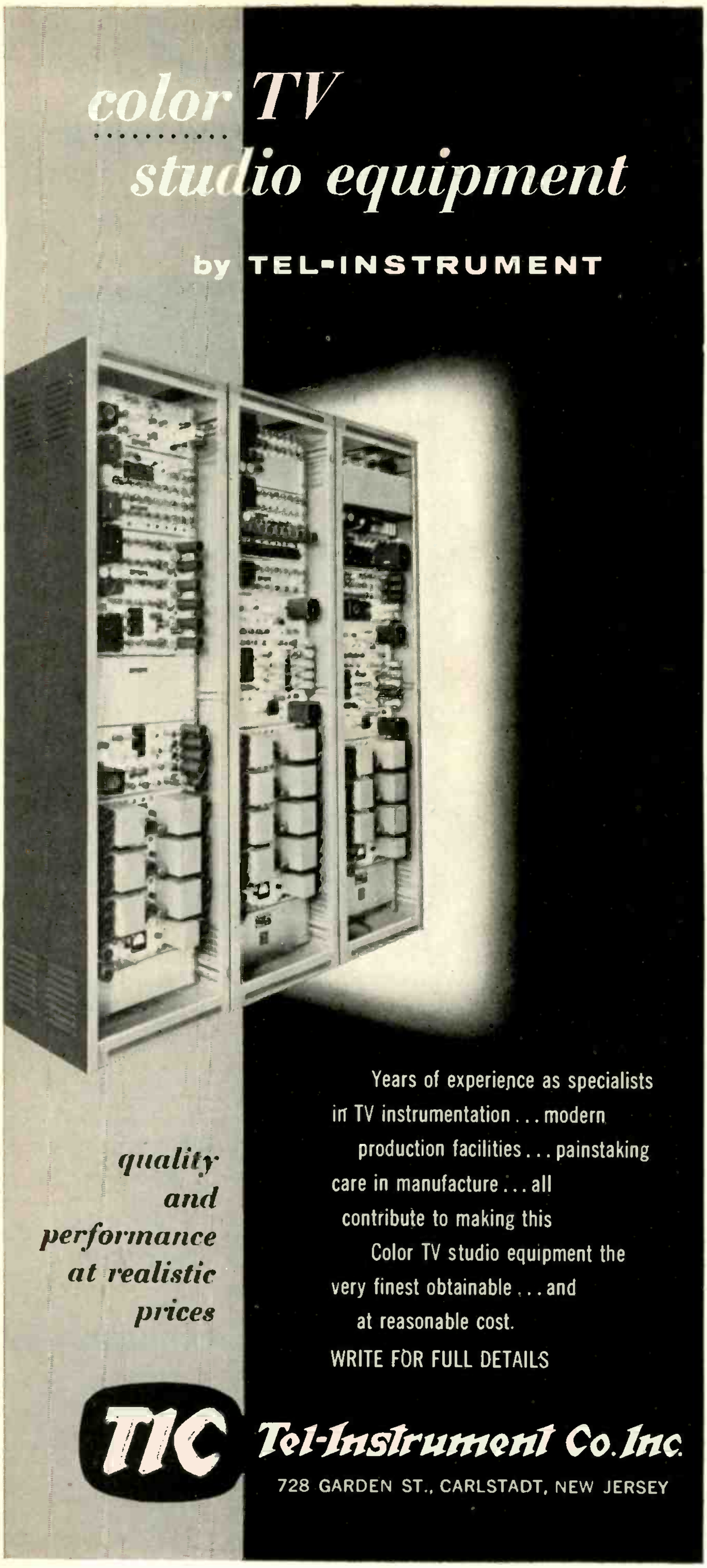

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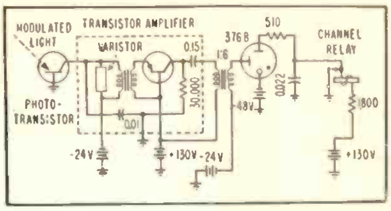
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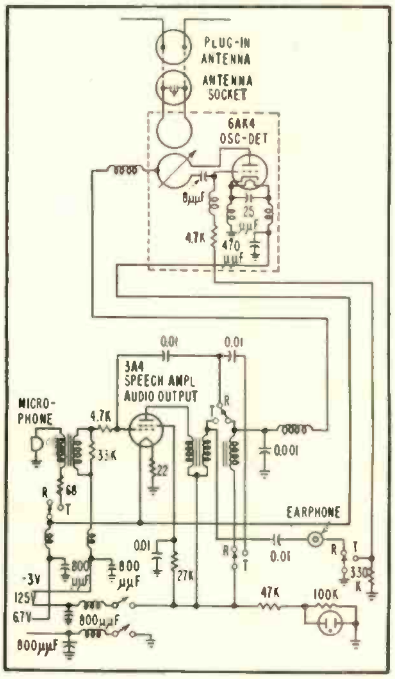
Transistor amplifier boosts signal from phototransistor to trigger cold-cathode tube

transistor is then applied to the transistor amplifier.

The amplifier is a conventional common-base circuit having a voltage gain of 40 to 100. The amplifier output triggers a cold-cathode gas tube operating a relay.

This information has been abstracted from an article "Transistors in 4A Toll Crossbar Switching" by P. Mallery, appearing in *Electrical Engineering*, Feb. 1954.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R
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125V
67V
800μμF
47K
100K
800μμF

Portable Transceiver Circuit

Circuit of the portable transceiver described previously (p 204, Electronics, May 1954) is shown above. Stewart-Warner Electric, manufacturers of the Portafone, emphasize that the equipment is furnished as a unit and is designed mechanically as well as electrically to comply with FCC frequency tolerances with service by a licensed operator. Amateur or other equipments based solely upon the circuit diagram are not likely to meet requirements for the Citizens Radio band

(*Continued on page* 220)

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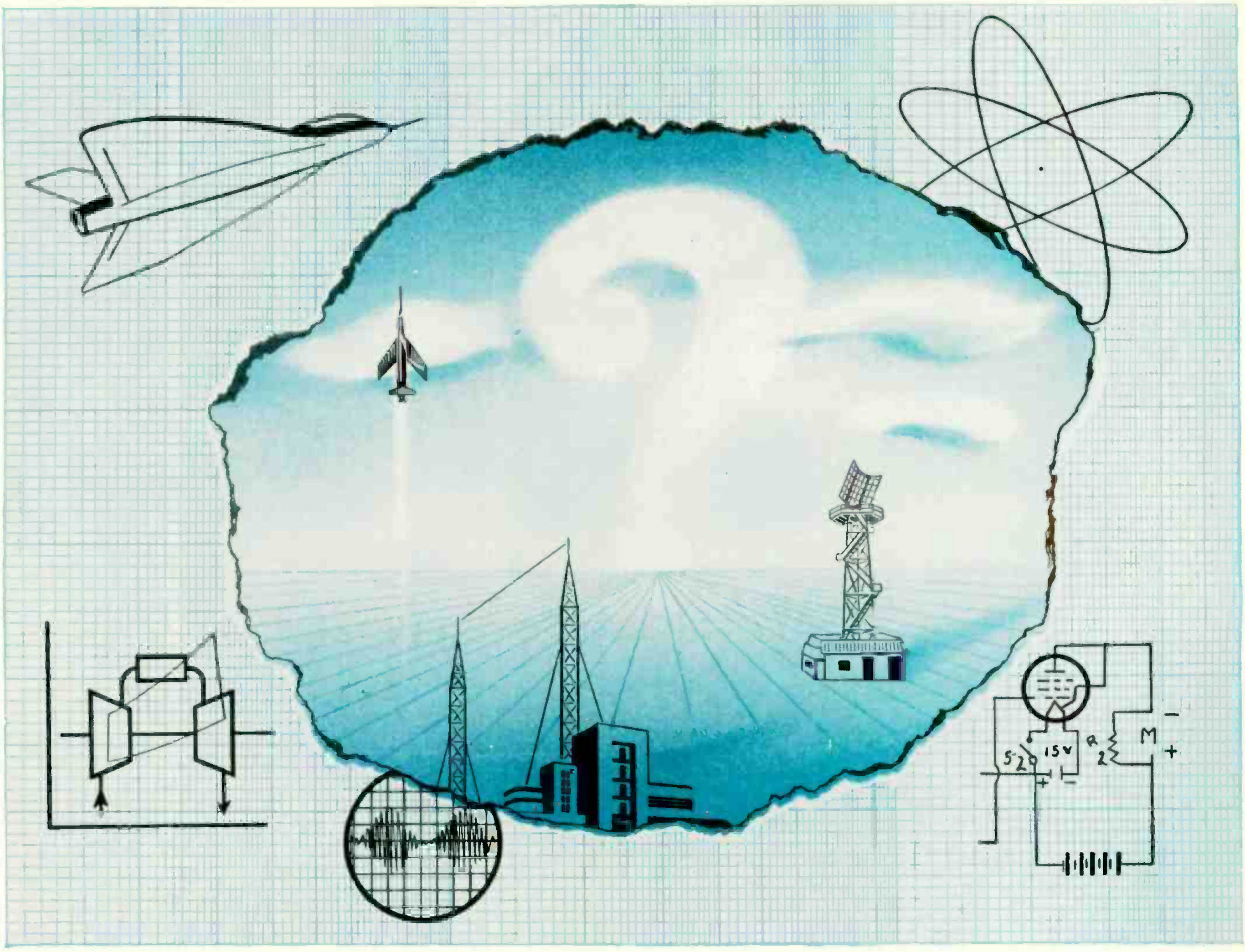

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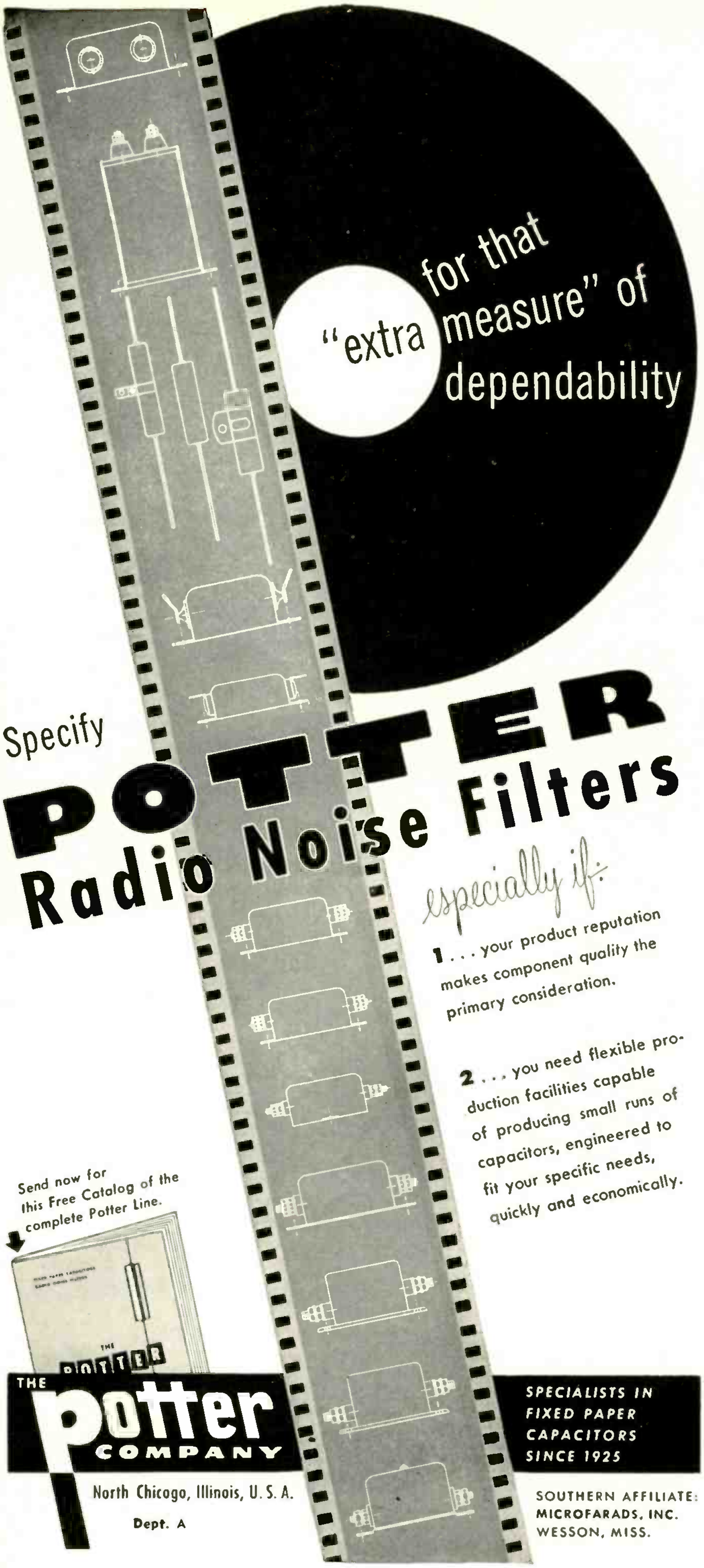

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PERTINENT PATENTS

By Norman L. Chalfin
Hughes Aircraft Co.
Culver City, Calif.

Information concerning fabrication and use of transistors occupies a large part of technical publication. This same interest and activity is reflected in patents issued. This month's selection summarizes information on three such patents.

Transducer

Patent 2,666,861 for a transducer has been issued to R. D. Campbell, assignor to Reed Research, Inc. of Washington, D. C.

The circuit of this device is shown in Fig. 1 and is designed to convert a voltage of varying amplitude into a pulse signal having a repetition rate directly proportional to the applied voltage.

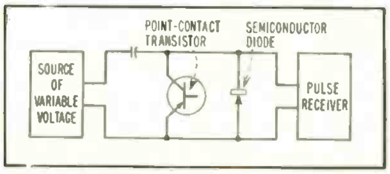

FIG. 1—Transducer changes varying voltage to pulse signal

The operation of the circuit is fairly simple and may be followed with reference to Fig. 2. As a voltage is gradually increased from the value *O* to *A* no appreciable change in current occurs through the transistor body and little charge appears across the capacitor. When the voltage value *A* is reached a sudden current surge occurs and the capacitor is rapidly charged and the voltage across the transistor is diminished to the value indicated at *B* in Fig. 2 at which time conduction ceases.

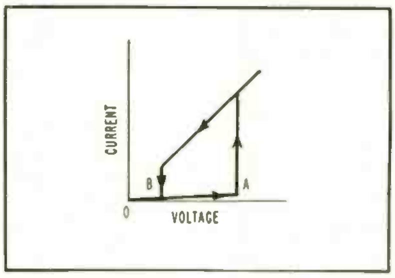

FIG. 2—Operation of circuit of Fig. 1

Voltage from the source continues

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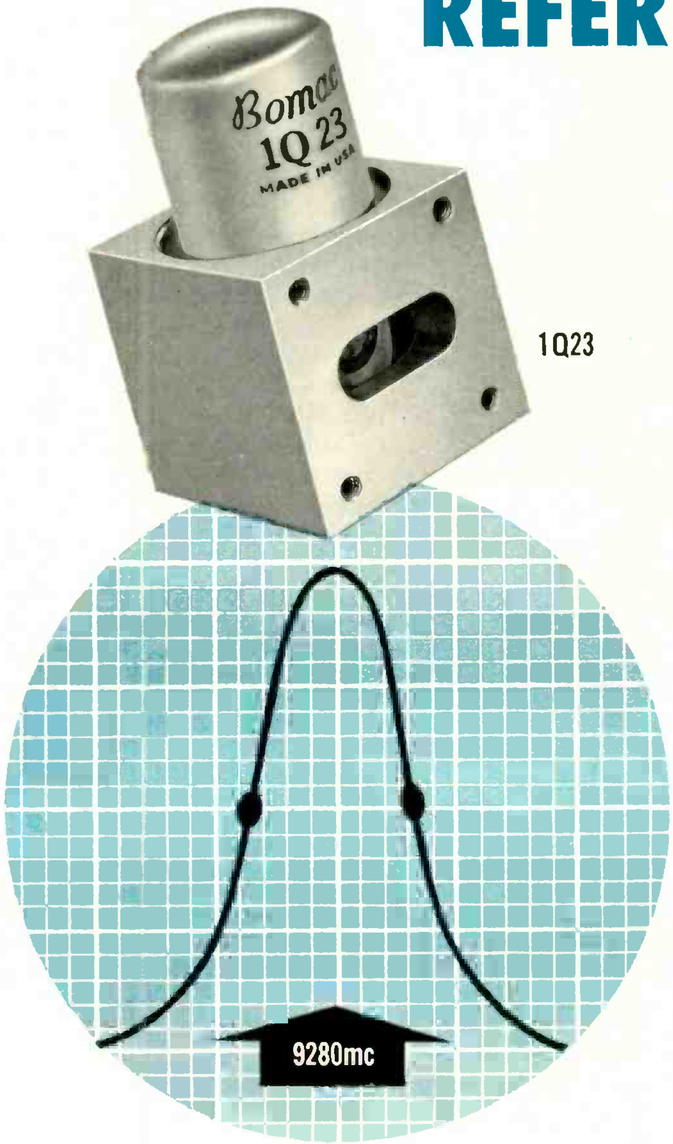

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SHOCK 50 G's	± 0.1 mc
AVERAGE Q	2100
INSERTION LOSS	4.0 db – 6.0 db
TEMPERATURE COMPENSATION	
Room Temp. to 100°C	± 0.3 mc
Room Temp. to 0°C	± 0.3 mc
Room Temp. to –55°C	± 1.0 mc
ATMOSPHERIC PRESSURE	
To 45 psi (abs.)	± 0.15 mc
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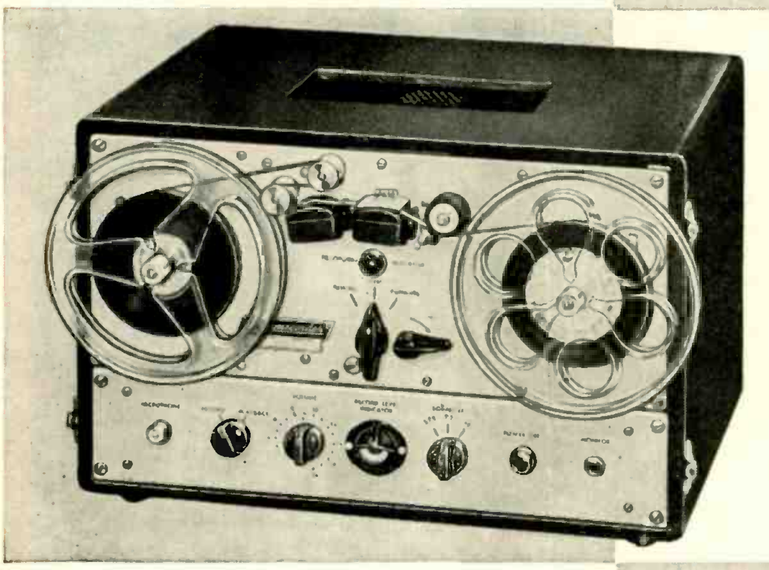

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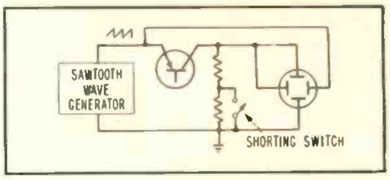

FIG. 3—Circuit used to form semiconductor

to increase, however, and when the difference between the charge across the capacitor and the added voltage from the source again equals a value *A*, across the transistor, sharp conduction occurs, repeating the sequence described above. This continues as long as there is an increase in the source voltage. The resultant, therefore, is a series of pulses that has a repetition frequency determined by the amplitude of voltage applied from the source.

Primarily, a circuit of the type shown has utility in analog-to-digital conversion of data to computers. The recovery time of the transducer is short enough and the voltage steps small enough vastly to increase the accuracy and speed of this device over the prior art. Values indicated in the patent disclosure suggest recovery times of less than 1 microsecond and voltage increments of less than 0.1 volt.

Forming Transistors

From England comes a device connected in similar fashion to the device described in the Campbell patent.

A U. S. patent 2,653,374 has been granted K. A. Matthews and C. D. White of London, England, assignors to International Standard Electric Company of New York; for an "Electric Semiconductor."

The invention herein disclosed is actually a means or method of elec-

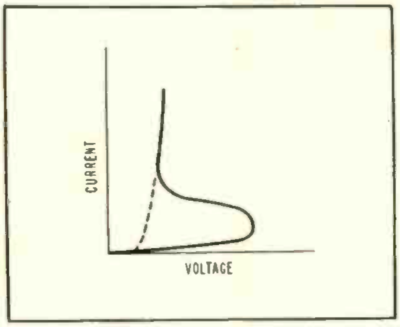

FIG. 4—Linear curve shown by dashed line

After a 5g Turn

IS THE DATA VALID?

The moment an oscillograph is taken out of the laboratory for aircraft flight testing, vehicle road tests, or any application where vibration and dynamic g forces are present, the "balance" of its galvanometers — the measure of their response to gravitational force — becomes all-important. An unbalanced galvanometer can cause deflections — under only moderate g-loadings — large enough to distort a data trace and make accurate record interpretation impossible. It can show deflections even when no data signal is present.

Miller Instruments' *improved* galvanometers are supplied *at no extra cost* with balance so closely controlled that trace deflection is within 0.010" per g in elements of less than 300 cps natural frequency and within 0.001" per g for higher frequencies. The unique open construction allows balancing to be the *final* operation before shipment. No subsequent assembly steps disturb the balance achieved. Trace deflection due to g forces displacing the suspension is negligible.

Sound basic concept and extreme care in manufacturing and testing make Miller Galvanometers unequalled not only in their balance but also in their control of sensitivity, linearity and stability. Inaccuracies have been literally "designed out." The unusual fineness of the traces they produce have long been the standard in oscillographic recording.

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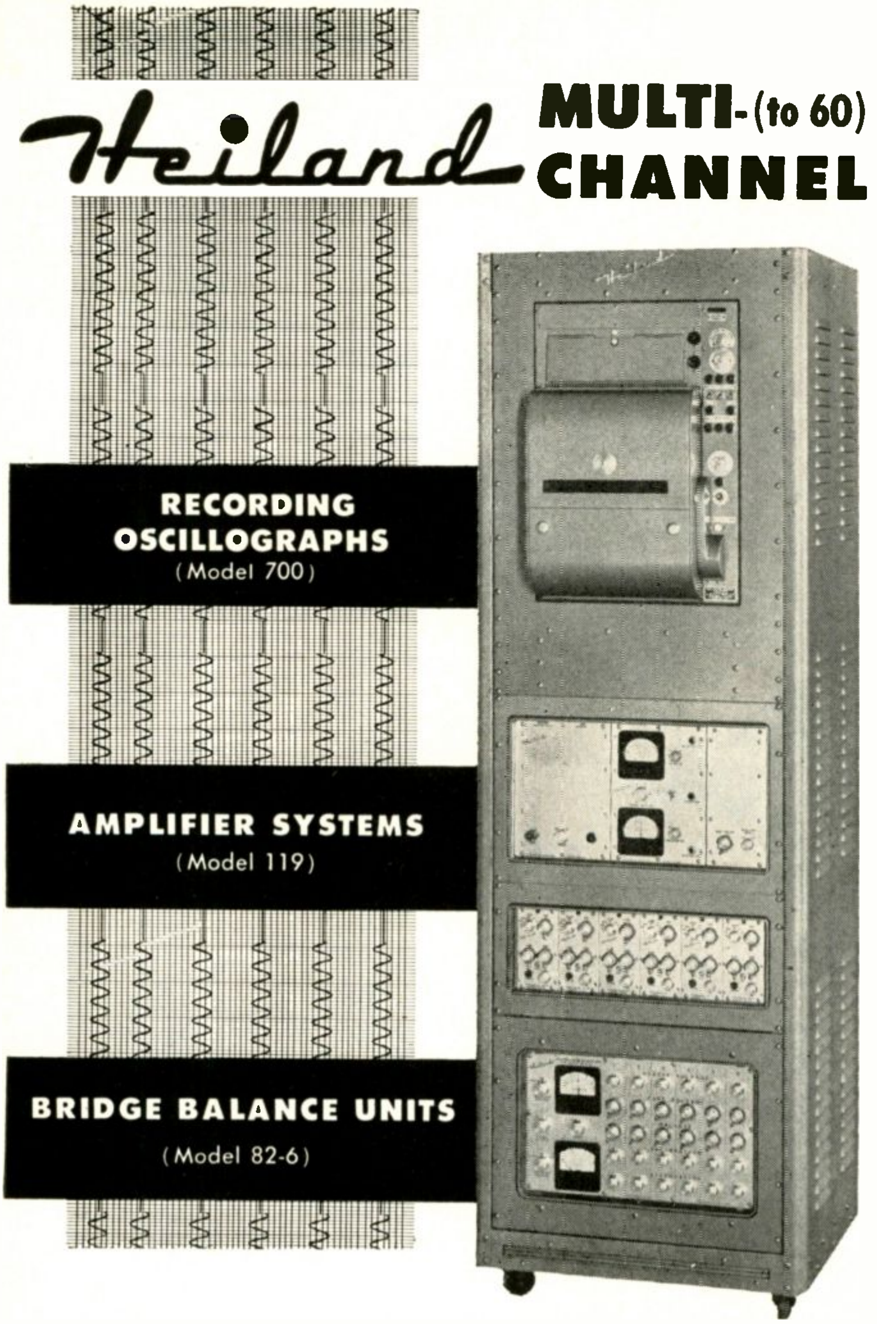
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trically forming crystal triodes (as they are termed in the specification) to eliminate the nonlinearity of characteristic response generally attributed to transistors.

The heavy curve of Fig. 4 shows the normal input volts vs output current characteristic of transistor units. When treated with a high-current sawtooth wave applied between emitter and collector as shown in Fig. 3, the semiconductor is formed to develop the linear characteristic curve shown in the dashed line of Fig. 4.

If, after a first shot of the high current sawtooth energy is applied, by closing shorting the switch shown to increase the current in the collector output circuit, the loop of the solid curve has not been eliminated, a second and a third shot will finally bring the response to the linear curve sought.

Note that in the circuit of Fig. 3 the base of the transistor is unconnected. The energy is applied only in the emitter-collector path.

Transistor Amplifiers

A number of "Transistor Amplifier Circuits" is the subject of U. S. Patent 2,652,460 awarded R. L. Wallace, Jr. of Plainfield, N. J. and assigned by the inventor to the Bell Telephone Laboratories of New York.

The importance of the present invention lies primarily in its setting forth the duality between transistor amplifiers and vacuum-tube amplifiers and the means whereby the operation and characteristics of the former may be predicted as the characteristics and operation of the latter are now predicted.

In particular the specification of the Wallace patent presents the

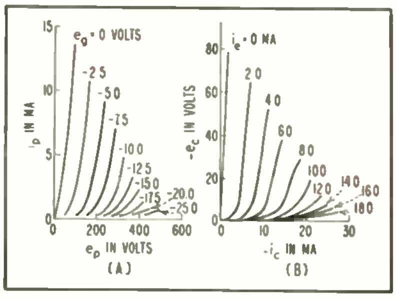

FIG. 5—Plate circuit curves for vacuum triode (A) and type A transistor collector curves (B)

various points of departure from which the analogous operation of vacuum tube and transistor amplifiers may be compared.

In Fig. 5A there is shown a typical family of plate circuit characteristic curves for a vacuum tube and beside it Fig. 5B shows a family of collector circuit characteristic curves of a type of transistor suitable for amplifier service. The analogy in this respect is clear from these curves.

In Fig. 6A and 6B a vacuum-tube triode amplifier and a transistor amplifier are shown side by side to illustrate their duality. The defining equations of each are set forth beneath to show the operating conditions of the two. The equations of the transistor circuit (B) are the transforms of those for the amplifier circuit of (A). The transistor circuit (B) satisfies the

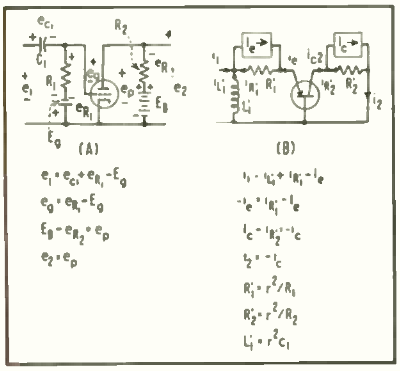
(A)
(B)
e1 = ec1 + eR1 − Eg
eg = eR1 − Eg
EB − eR2 = ep
e2 = ep
i1 = iL1' + iR1' − Ie
−ie = iR1' − Ie
Ic = iR2' − ic
i2 = −Ic
R1' = r²/R1
R2' = r²/R2
L1' = r²C1

FIG. 6—Duality shown by tube (A) and transistor (B) and accompanying equations

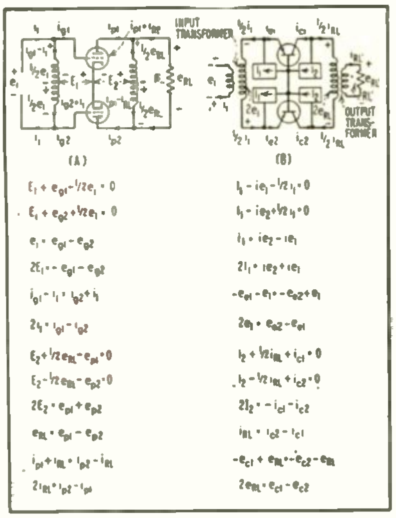
INPUT TRANSFORMER
OUTPUT TRANSFORMER
(A)
(B)

FIG. 7—Duality in push-pull amplifiers shown by equations

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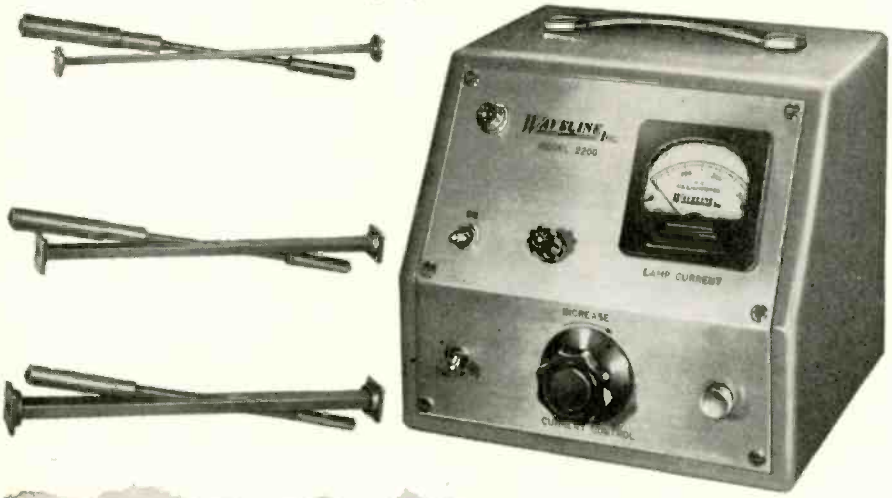

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transformation equations, shown below it, which make one circuit the dual of the other.

A vacuum-tube class-B push-pull amplifier shown in Fig. 7A has the operative relationships shown in the equations below it. Similarly, the push-pull class-B transistor amplifier, shown in Fig. 7B, is the dual of the circuit of 7A with its operative relationships in the equations below.

To obtain the high efficiency corresponding to class-B operation, the emitters of two transistors are biased toward high emitter current and the collectors toward high collector current so that collector current is cut off during approximately one half of each cycle. These bias conditions are shown in the curves of Fig. 8.

In the diagram of Fig. 8 the family of curves for one transistor are plotted back to back with those for the other transistor. A signal applied to the transistor circuit of Fig. 7B results in a current and voltage swing corresponding to the load line shown in Fig. 8 while in the absence of signal the collector voltages are both small compared to their values at the peaks of their swings.

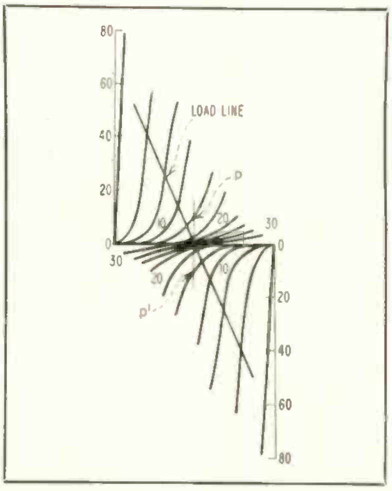


FIG. 8—Family of curves plotted back-to-back for push-pull transistors

To avoid distortion that would result from utilization of the highly nonlinear parts of their characteristics, which lie immediately adjacent to the current axis, the bias currents may be selected to locate the quiescent conditions of the two transistors approximately at points *P-P′* on the curves of Fig. 8.

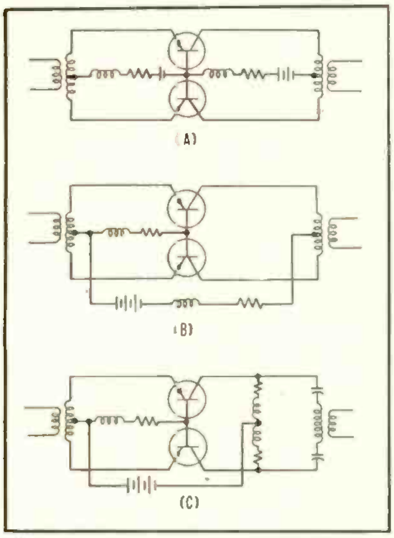


FIG. 9—Variations of the push-pull class B amplifier circuit

Figure 9 shows variations of the push-pull class B amplifier circuitry to provide simplifications of the power supply requirements.

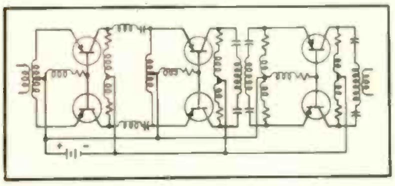
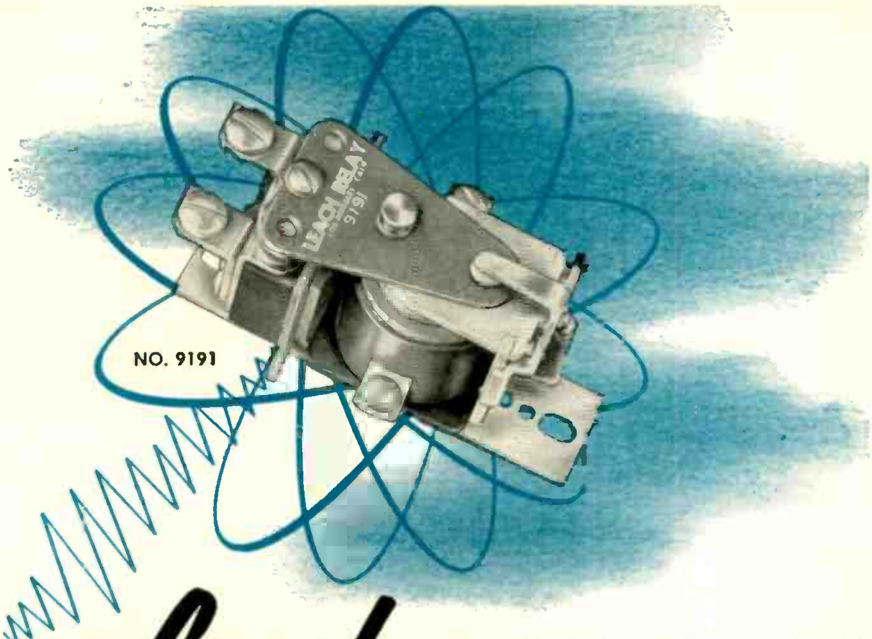


FIG. 10—Cascade of amplifiers employing common power source

Fig. 10 shows a cascade of amplifiers employing a common power source. Each stage of the amplifier may be operated either class B or even class C. Bias currents for the emitters may be obtained from choke coils and resistors in the common power source circuits.

More gain is obtained with the cascaded amplifier. The duality principle calls for feeding the collector current output from a preceding stage to the emitter of the succeeding stage. When each stage must be tuned, the duality principle calls for series-tuned rather than parallel-tuned circuits as may be seen in Fig. 10. In coupling from stage to stage, as shown, the transformer windings are adjusted to give the proper impedance transformation, as required in transistor circuits.



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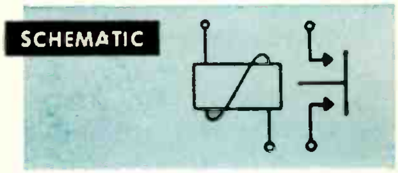
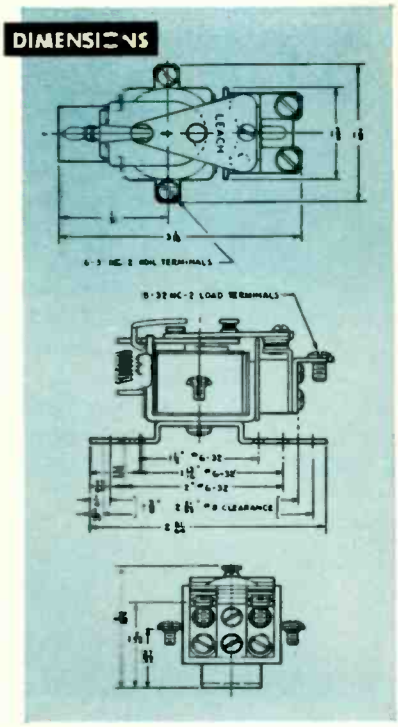
Standard coils are vacuum varnish impregnated. Multiple mounting holes in bracket allows relay to be mounted from above or below mounting surface as required.





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Production Techniques

Edited by JOHN MARKUS

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Automatic Fabrication of Resistor Terminal Cards

NEW TYPES of resistor cards and a machine that fabricates the cards automatically serve to eliminate screw machine, drill press and riveting operations to achieve a tenfold reduction in fabrication time at Hewlett-Packard Co., Palo Alto, Calif. The designer is R. M. Kingman.

The resistor-card machine performs three basic operations. It stamps a flat lug out of silver-plated brass ribbon, punches a hole in a phenolic board, and mounts the lug in the hole. The machine can also punch a number of large holes that can be used to mount the resistor card in an instrument.

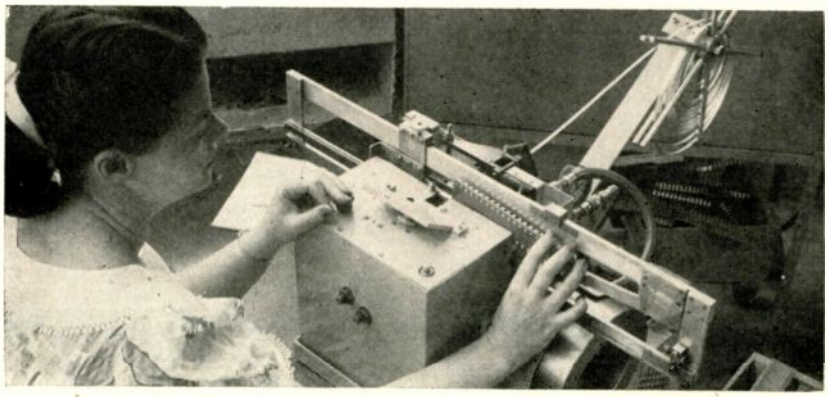
The silver-plated brass ribbon mounts on a spool at the back of the machine and is fed between a punch and die that forms lugs. A phenolic board or card, previously cut to desired size, is manually inserted into a traveling carriage at the top of the machine. This carriage carries the phenolic board past a punch and die in a stepping or indexing motion similar to that of a typewriter carriage. As the board moves through the machine, the punch stamps out small round holes along the edge of the board.

Into each hole the ribbon feed mechanism inserts a stamped lug, leaving the shank of the lug protruding from the back side of the board. A crimping punch crimps the shank, which is then set by a small automatic hammer, thus mounting the lug securely to the card.

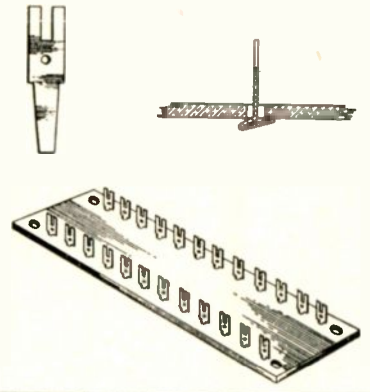
The machine continues this operation along one complete side of the card, after which the card is manually inverted and the process continued along the opposite edge. A separate punch and die are included in the machine so that mounting holes for the card itself can be punched at desired points along the card. A disabling cam prevents the insertion of lugs in these mounting holes.

Lugs are mounted at a rate in excess of 130 per minute. A typical resistor card having 10 pairs of lugs can be completely fabricated in about 15 seconds. Costwise, the machine-made resistor card amounts to only 1/7 to 1/10 the cost of conventional cards and at the same time frees valuable machine shop facilities.

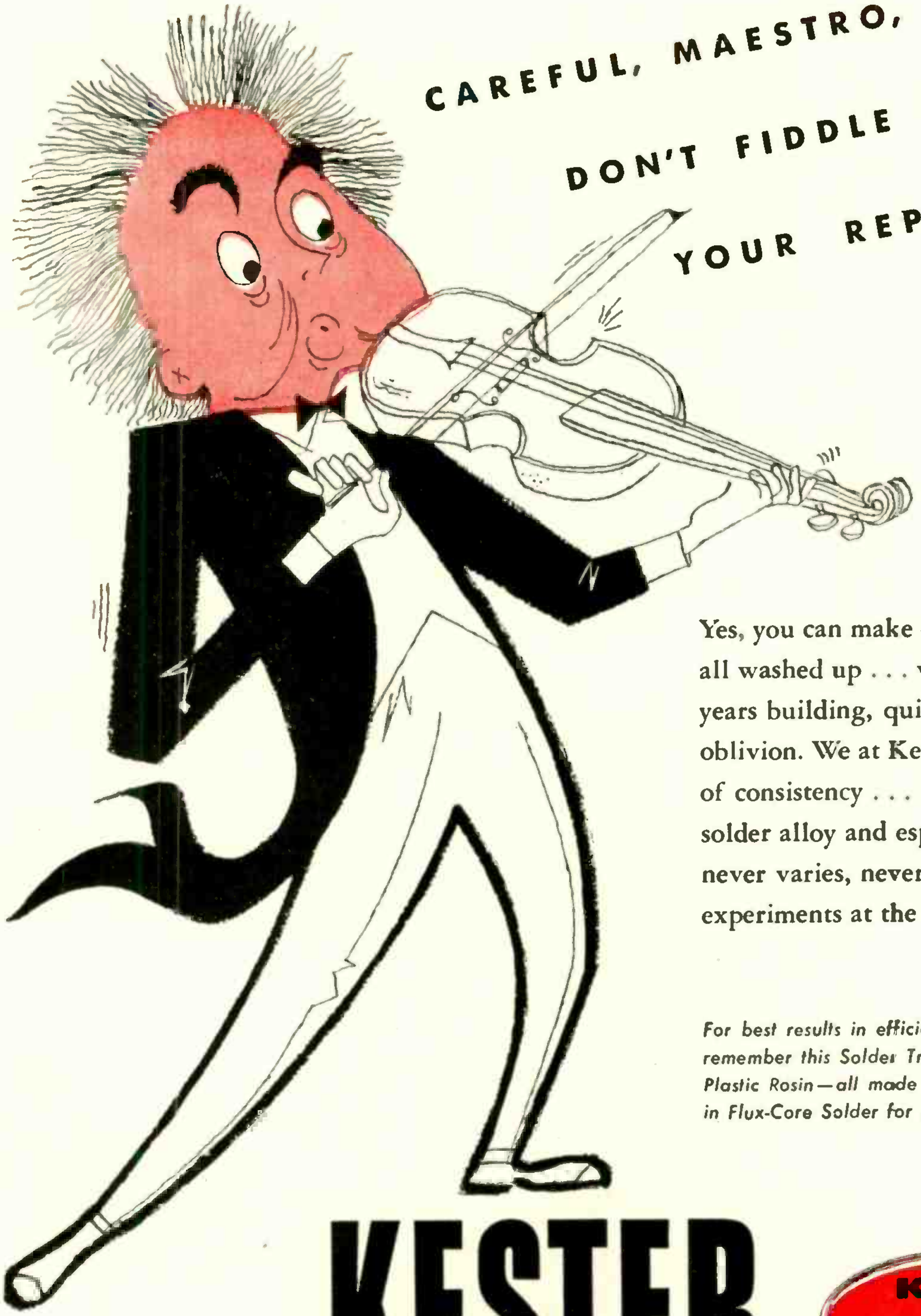
The machine-made resistor card also has a number of advantages



Automatic resistor card machine, which makes its own terminals from ribbon at rear and inserts them in holes punched one by one in plastic card



Details of new resistor card, showing how terminals are punched and staked



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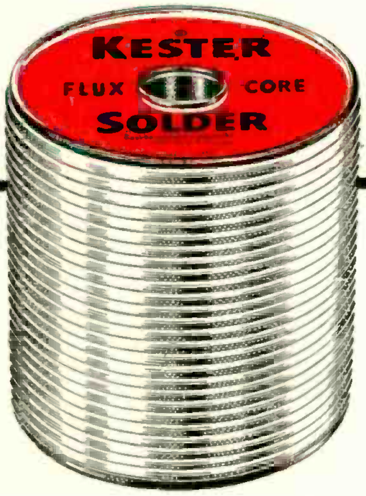

that improve the equipment in which it is used. The lugs are thin in the direction of resistor strain, so that danger of damage to resistors during and after wiring is minimized. Also, it is not necessary to wrap the resistor lead around the lug. The lead simply drops into the slot at the top of the lug. After the resistor is soldered into place, the excess lead is cut off.

Leads connecting to the resistor card are inserted through the round hole at the bottom of the lug and soldered without wrapping. The mechanical joint formed by soldering is good. Completely fabricated resistor cards with components mounted thereon do not show weakness when subjected to military type vibration and shock tests in finished equipment. The simplicity of wiring also reduces labor costs required for wiring in components.

Since neither the resistor lead nor connecting wire is wrapped around the lug, an otherwise difficult servicing problem becomes easy. Any component can be disconnected by heating the terminal and lifting the lead out of the slot. Connecting wires can be removed by pulling the wire out of the round hole after the lug has been heated.

Wire Spool Rack

USE OF THE PROPER lead wire for tap connections on precision potentiometers is facilitated by a coded spool-holding rack at Helipot Corp., South Pasadena, California. Each of the many alloys and weights of wire is assigned a code number. The 50-peg dispenser holds these wires on individually numbered spools.

Spool rack alongside tap welding setup

Elasticized-Edge Plastic For Tote Boxes

STANDARDIZED SIZES of boxes for parts and finished components stack and tote with a minimum of inconvenience at Helipot Corp., South Pasadena, Calif. A clear plastic cover with elasticized edges protects contents and keeps them visible. Tickets attached to the box identify contents when boxes are stacked.

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INEXPENSIVE wood boxes having felt-padded semi-circular cutouts in the end serve as supports for Amperex type 3000M rotating-anode x-ray tubes during final assembly. Two styles of racks are used in the Hicksville, N. Y. plant of the firm, one for individual tubes and one for a batch of six tubes.

The racks are used to hold the tubes during the final operations of placing spaghetti tubing and nylon caps on the leads at one end, and cementing a cork protective band around the glass envelope at the other end. For the cementing operating, a cork strip is coated with GE No. 1286 Glyptal cement and the strip is wrapped around the tube. A simple metal band

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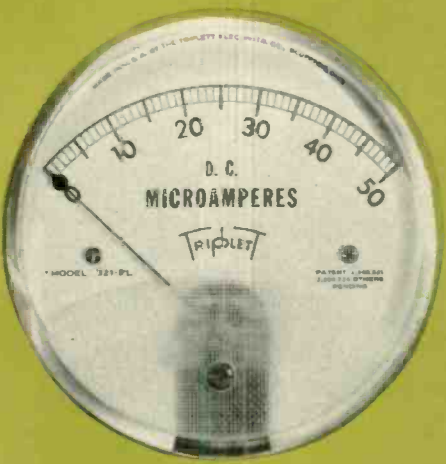
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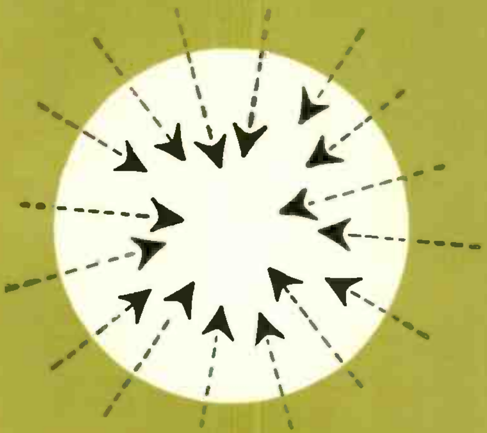

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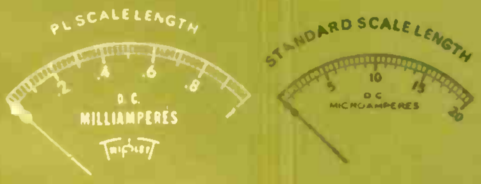
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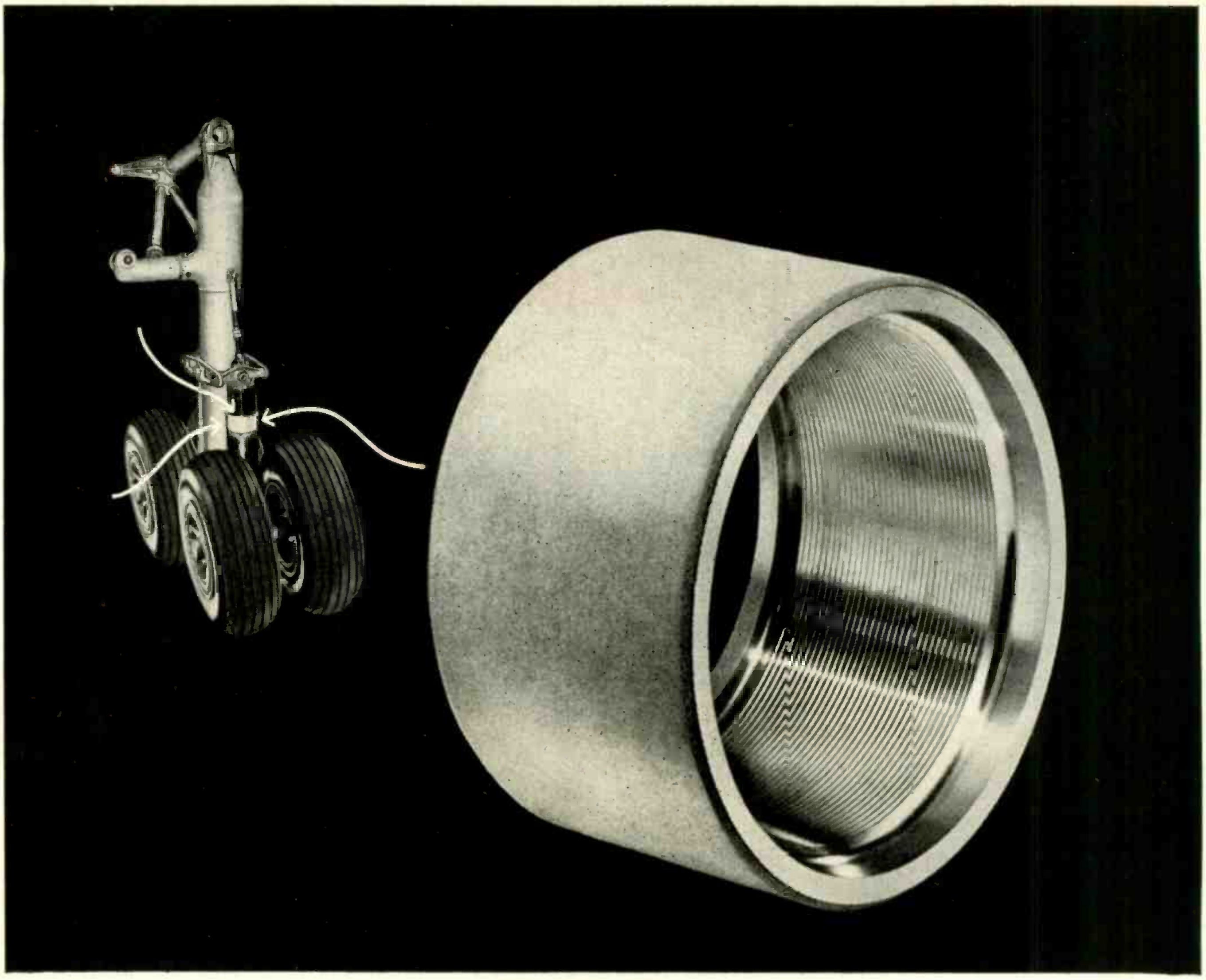

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● A major problem in aircraft design since the very beginning has been proper landing gear. The Wright brothers used rigid, sled-like runners. For many years shock cord—giant-sized rubber bands—took up the load. As planes grew larger and landing speeds climbed, the modern air-oil shock strut was developed. An important component in the largest landing gear struts now made is *Synthane*—a laminated plastic.

The pistons used in shock struts must be tough, mechanically strong, shock-resistant, machinable, light in weight, impervious to oil, long-wearing and non-scoring. They must bond securely to aluminum cores. Dimensional stability is necessary over a wide range of operating temperatures. *Synthane* supplies all of these needed properties.

There are hundreds of applications for *Synthane's* electrical, chemical and mechanical properties. More than 33 different grades of this versatile laminated plastic help to fulfil a variety of specifications. If you have need of a material with many different properties in combination, *Synthane* may be your answer. Our catalog supplies full information about *Synthane* sheets, rods, tubes, and fabricated parts. To get your copy, please write us. Synthane Corporation, 12 River Road, Oaks, Pennsylvania.

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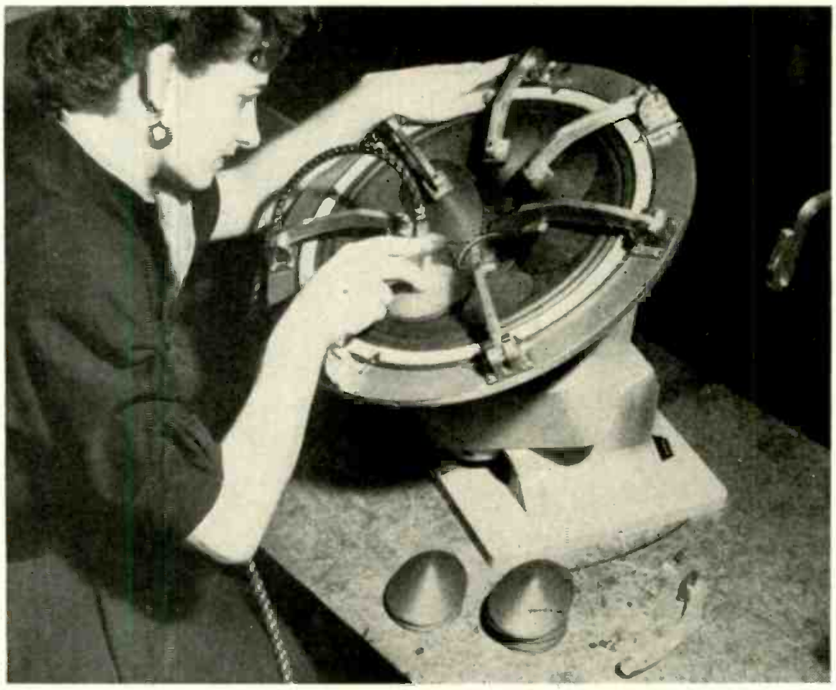
SYNTHANE

LAMINATED S PLASTICS

tightened around the strip holds it in place until the cement has set with the aid of heat from a 250-watt infrared lamp. This lamp is in a socket mounted on a board resting on top of the workbench back, a heavy metal weight being used on the board to counterbalance the weight of the lamp. This simple arrangement permits swinging the lamp to any desired position or moving it.

Vacuum Cup Positions Domes on Speakers



Method of using vacuum-actuated tool for picking up paper dome and placing it in precise position on loudspeaker diaphragm. Projecting studs on handle of tool fit into slot in bracket just under operator's right wrist to determine position of dome

THE PROBLEM of cementing seven sound-diffusing cones on the diaphragm of the RCA type LC1A 15-inch high-fidelity loudspeaker was solved in the firm's Camden plant by devising a vacuum-actuated positioning tool that works in conjunction with an angle-mounted rotating fixture supporting the entire loudspeaker. So perfect is the resulting fit of elliptic-based domes to the conical inside surface of the diaphragm that cement flows under the edges by capillary action to give perfect anchoring, with no gaps to cause rattles.

The first step is trimming the edges of the domes so they will be parallel to the surface of the diaphragm when installed. The domes are molded from paper pulp to a thickness of about 0.015 inch in much the same way as loudspeaker diaphragms are made, and come from the vendor with a surplus flange. Each such dome in turn is placed in an arbor-press fixture having a contoured recess, and the press is operated by hand to bring a mating plunger down into the dome. The top of the fixture and the top of the plunger are then in correct alignment to serve as guides for trimming. The operator simply holds a razor blade over the flange and spins the fixture to cut off the surplus paper. Fixture and plunger are designed to permit this rotation. A razor-blade holder is used, and blades are changed frequently.

For the second step, the operator places a loudspeaker in a large metal holding fixture mounted at an angle on a support that rests on the bench and rotates in a horizontal plane. Spaced around the flange of the fixture are seven supports for the dome-positioning tools, each with its pivot slot spaced a different distance out from the center of the

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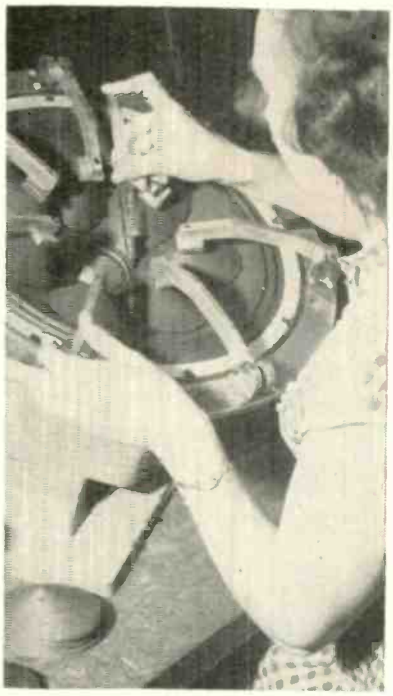
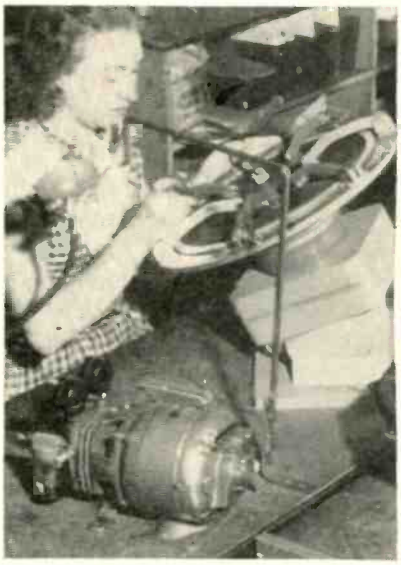


Applying cement around domes with hypodermic syringe while weighted tools hold the seven domes in position. Entire fixture rotates to bring domes into working position

loudspeaker. This serves to place the domes on a spiral rather than a circle, to break up standing-wave patterns.

The operator picks up a trimmed dome with a master positioning tool that is equipped with a vacuum cup. Vacuum is provided by a vacuum pump driven by a quarter-horse-

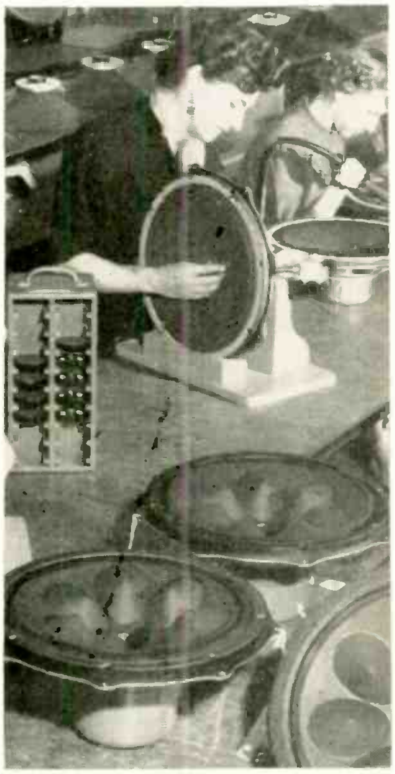


After placing dome in position, operator hangs vacuum tool out of the way on the overhead support bracket and places a weighted arm on the dome to hold it in position. Vacuum pump is in foreground on bench power electric motor, located on the bench alongside the work position. A foot switch controls the motor to start and release vacuum as desired. The vacuum lifter prevents deformation of the dome such as might occur if picked up with the fingers, and serves to keep the dome clean as well as position it.

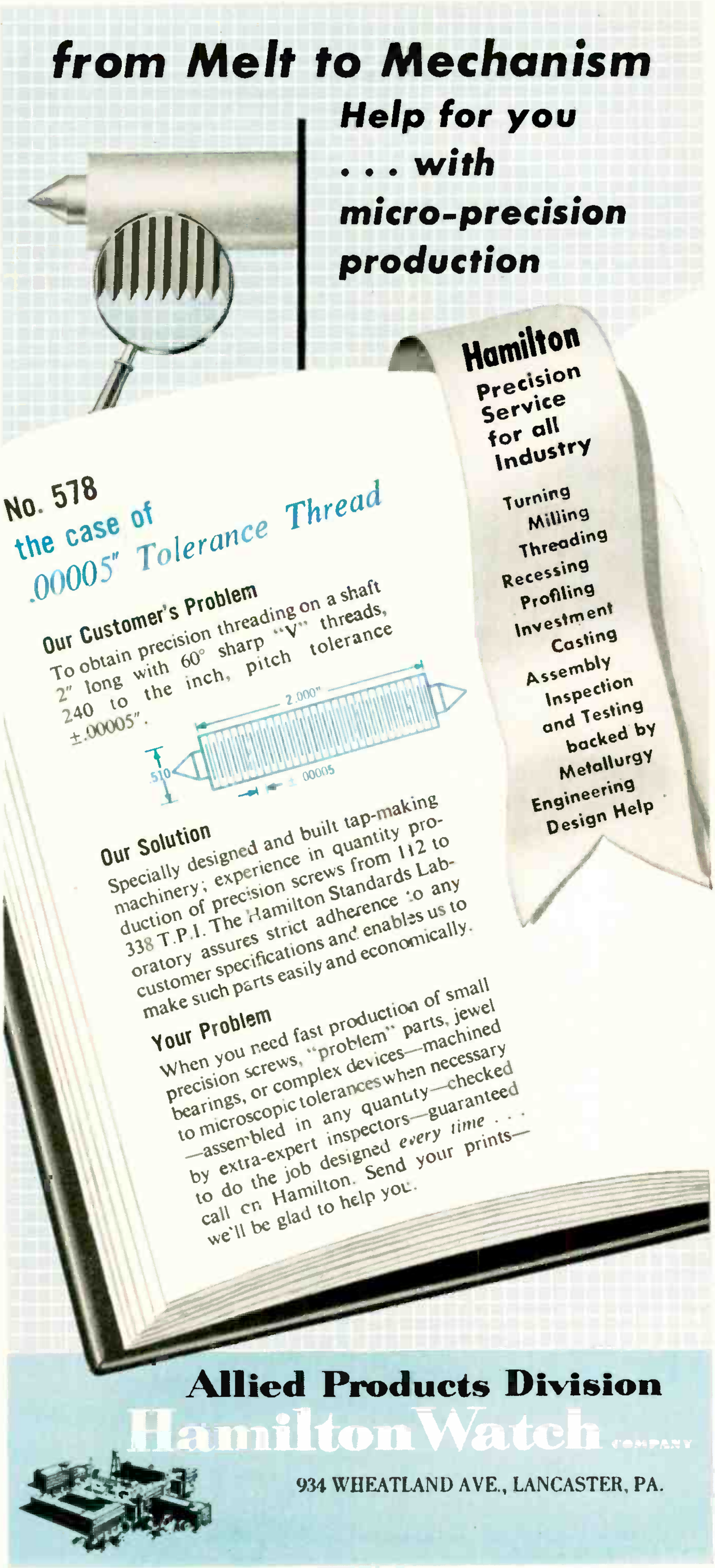
Assembly Procedure

Dome positioning is done simply by placing the lifting tool in the bracket nearest the operator and bringing it forward to press the dome gently against the diaphragm. The vacuum pump is then stopped to release vacuum, the tool is lifted up carefully so as not to disturb the dome, and a plain weighted tool of similar shape is put in place to hold that dome in position. The loudspeaker is then rotated one-seventh of a turn and the procedure is repeated for the next dome.

When all seven domes are in position, the operator takes a hypo



Type of wood fixture used for holding loudspeaker vertically during assembly of spider, inner tweeter and other components. Wood carrying case with handle serves for transporting and protecting circular corrugated spiders with attached voice coils. Finished loudspeakers can be seen on table in foreground



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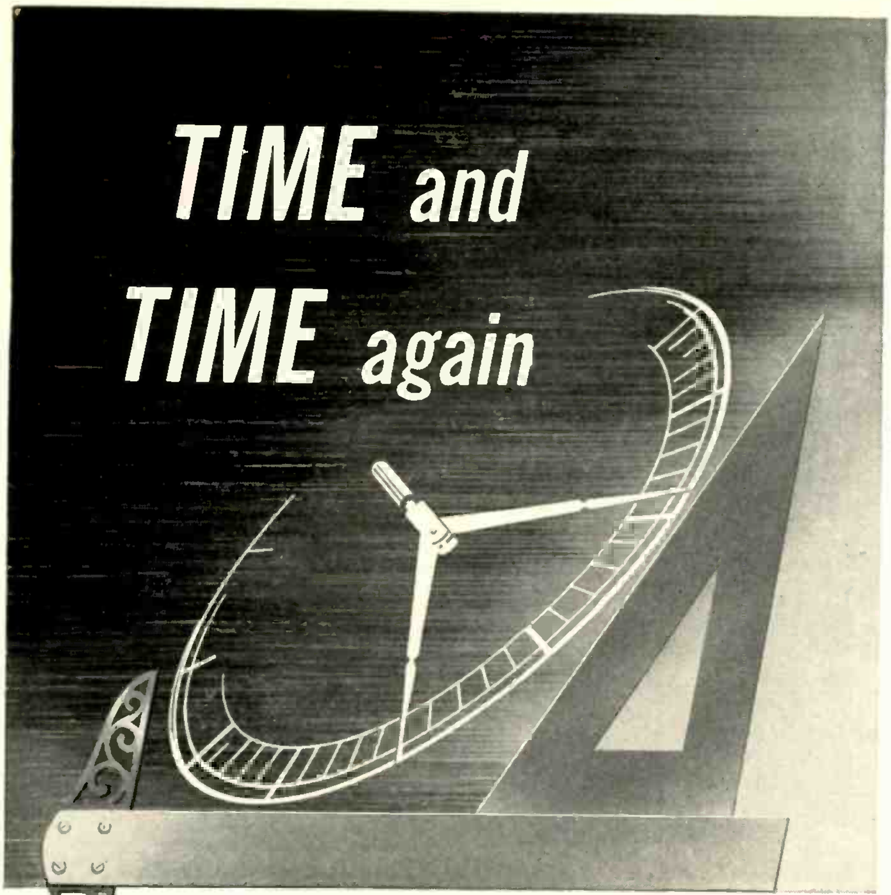

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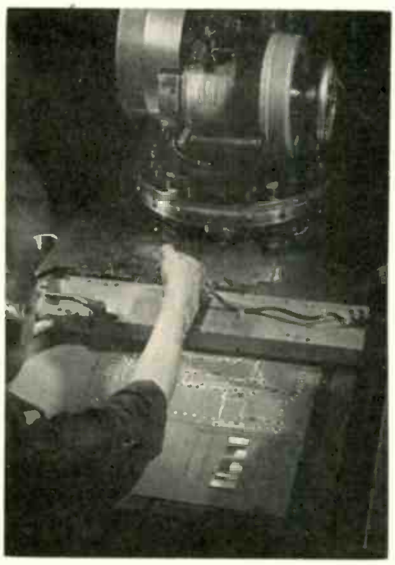
syringe filled with an air-dry lacquer-type cement and runs it around each dome in turn, to flow cement under the edges of the domes by capillary action. The edges of the domes serve as guides for speeding up application of cement. After this dries, the weighted holding tools are removed and a second coat of cement is applied to form a fillet around each dome.

Although the diaphragm appears to have corrugations, it is actually smooth on the inner side so that a good fit to the domes can be obtained. The effect of corrugations is achieved by molding to give variations in the thickness of the diaphragm.

Use of Turret Press for Short Chassis Runs

THE FLEXIBILITY of the Wiedermann turret press has proved highly advantageous for chassis and other metal punching work associated with production runs of from 100 to 500 a month in the Palo Alto, Calif. plant of Hewlett-Packard Co. Shorter runs can be most economically handled on individual punch presses; more would justify a die set.

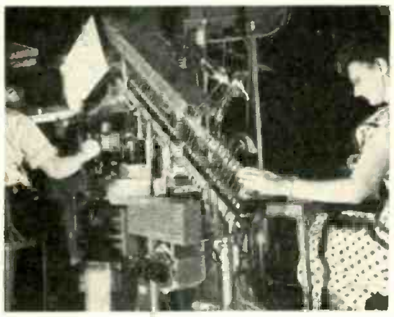
This machine has 20 different punches which can be operated in any sequence. Changes in the



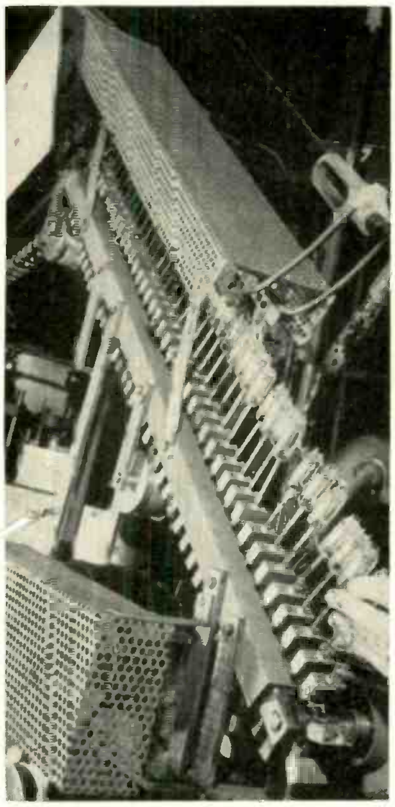
Using turret press with template for punching total of 147 holes of 17 different sizes in chassis blank for distortion analyzer. All holes made with one punch are tied together with colored lines on template, coded to color keys over punches in press master template can be made in 3 minutes simply by plugging up the old holes and punching new ones. At present, some 75 different templates are in active use.

Broken-Back Preheater for Tube Sealers

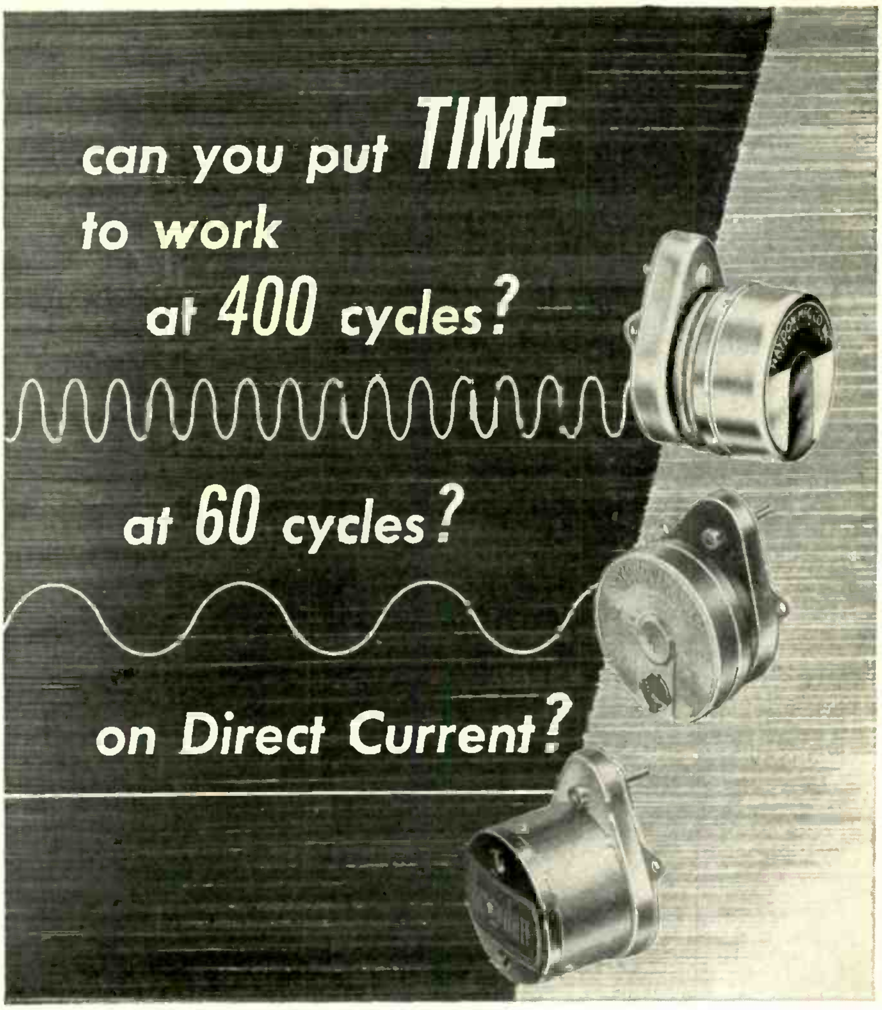
HIGHER production rates are obtained in sealing radio tube mounts by replacing the slower circular preheater with a new conveyorized oven developed in the New York City Radio Tube Division headquarters of Sylvania Electric Products, Inc. The conveyor has a rather sharp bend in the middle to conserve space, and from this comes



New preheating conveyor, with sealing machine in background



Method of loading tubes on conveyor upside down



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the descriptive broken-back terminology.

The conveyor operator places tube mounts in bulbs upside down and inserts the pump-off tubulation in a block which is bolted to the bicycle chain that serves as the conveyor. This chain transports each tube assembly through the preheater, which uses an electric heating element.

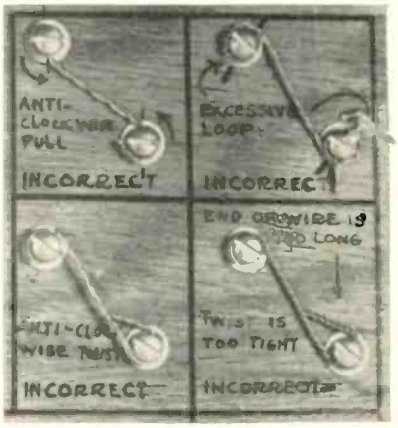
The output end of the conveyor is only about 4 inches from the right hand of the sealing machine operator. He takes the preheated envelopes off the conveyor and inserts them into his bulb sealing machine.

DALMO VICTOR
SAFETY WIRING

Display Board Teaches Safety Wiring Techniques

A MODEL safety wiring board, designed primarily to prevent mechanical failures on airborne radar antennas because of dislodged screws, has been developed by Dalmo Victor Co., San Carlos, California.

The unit illustrates common wiring and break-out faults as well as the correct method of providing a locking action for the screws. It



Examples of incorrect wiring on board

also designates the correct gage wire to be used on screws of varying sizes.

The boards were designed by Peter Chang, assemblyman, and have been installed throughout the company's assembly areas. They are proving an excellent aid in training new personnel.

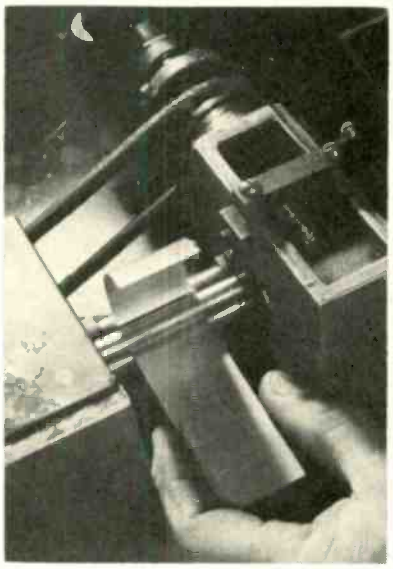
Machining Contact Fingers for UHF Cavities

FABRICATION TIME on ultrahigh-frequency contacts was cut by 80 percent and a better product obtained through development of an ingenious machining operation by Hewlett-Packard, Palo Alto, Calif.

Formerly it had been customary to hog the contact out of a solid slug of beryllium copper. This procedure resulted in only a reasonably satisfactory contact; fabrication cost was high and life expectancy short.

In the search for a better product, production engineers first bonded a solid silver overlay to the ends of the contact fingers to lengthen the life of the contacts. While this gave excellent performance, fabrication costs were still high.

After long study, a completely different fabrication process was



Beryllium copper strip 0.006 in. thick and 1½ in. wide is formed into cylinder on rolling mill. Forming strip into cylinder makes the shape rigid, permits edging with silver ring. Silver wire could not be soldered to flat strip of this material without buckling

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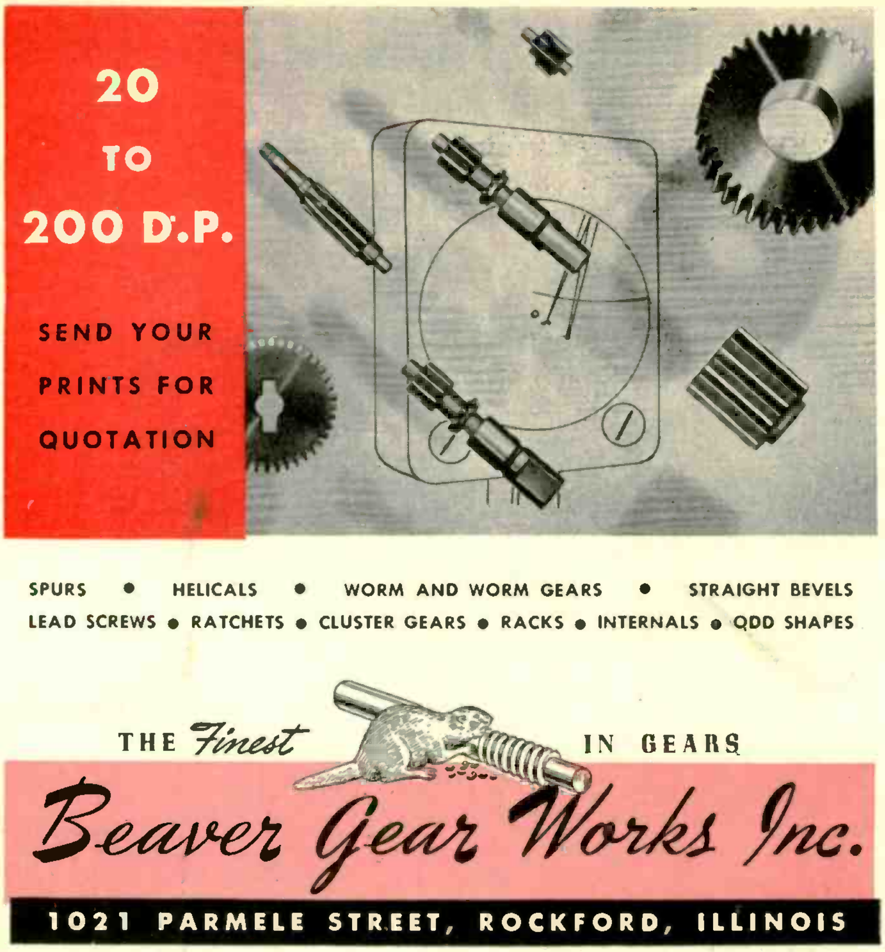

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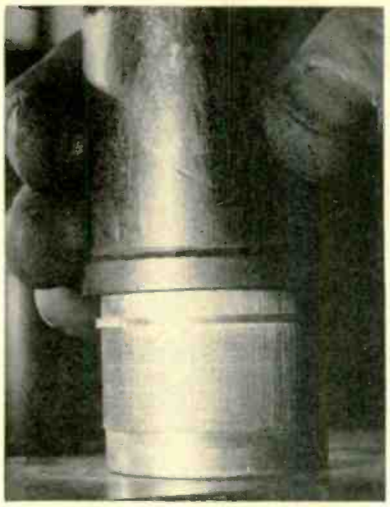
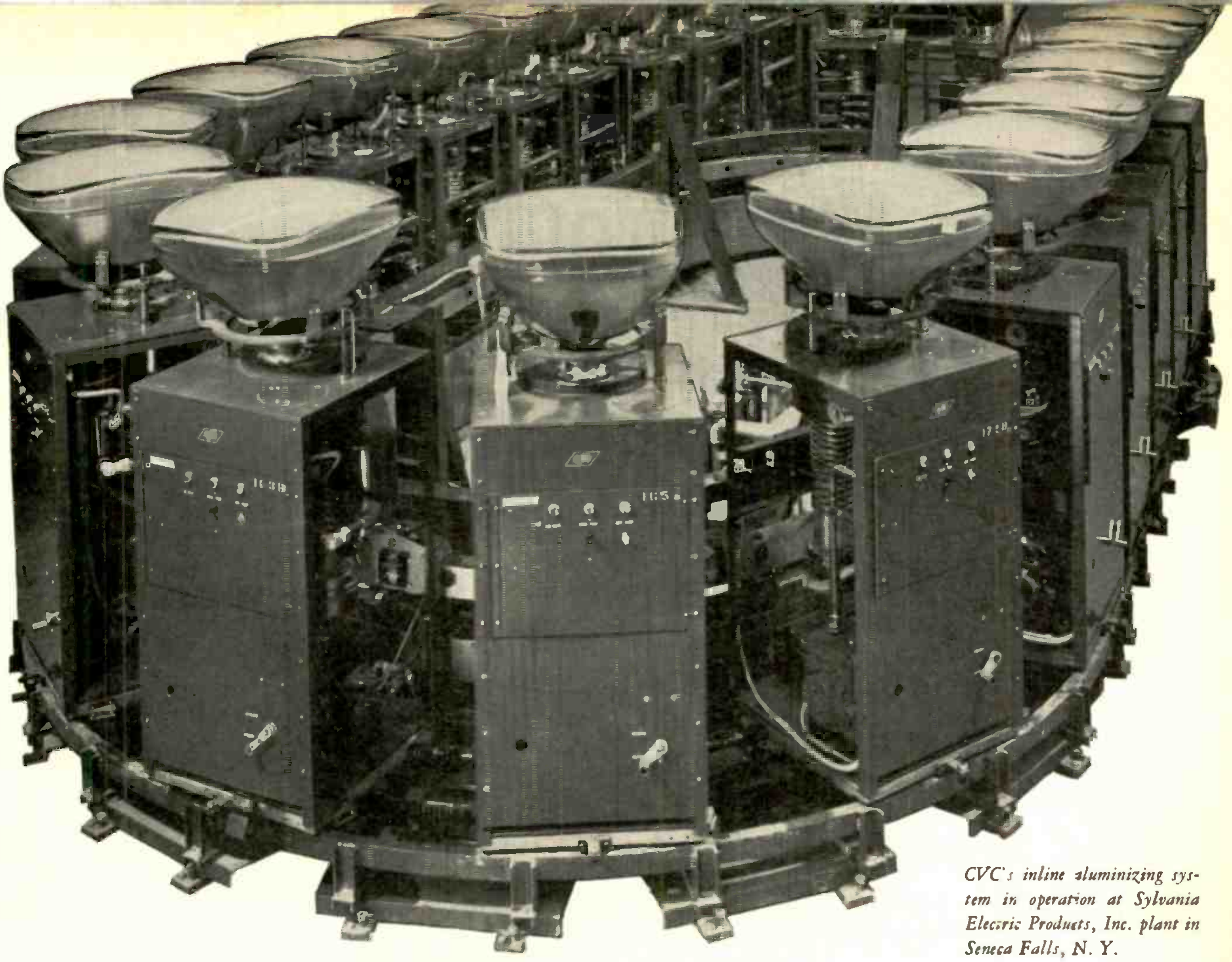


Silver ring is sized on mandrel as is shown here, before being placed on cylinder. Silver overlay bonded on ends of contact fingers lengthens life of contacts, gives excellent performance

Brass ring is slipped inside of cylinder and first silver ring is placed on outside. Workman places brass ring to aid in brazing operation. In the oven the asbestos pad retards the melt of the bottom ring. Placing the ring slightly closer to top than to bottom draws heat away from top, evens the melt

worked out. Instead of hogging out a solid slug, the process now starts with a strip of beryllium copper sheet. This is rolled into a cylinder and a silver ring slipped over each end. The rings are then brazed to the sheet in a furnace.

After brazing, the rings are cut at the joint in the cylinder and reopened to a flat strip. Fingers are formed from the strips by grouping eight strips in a packing fixture and slotting the whole pack with a saw



CVC's inline aluminizing system in operation at Sylvania Electric Products, Inc. plant in Seneca Falls, N. Y.

Another CVC first in cutting TV tube processing costs

Here is an inline vacuum system capable of aluminizing TV tubes with the same efficiency and high production rates as the famous inline exhaust systems pioneered by *CVC*.

Similar to the exhaust system, individual aluminizing units move around an oval track. One revolution completes the aluminizing cycle. Each cart is completely self-contained with mechanical and diffusion pumps, valves, power pickups, and controls for automatic operation. The operator need only load and unload tubes and replenish the aluminum on the filaments.

This new *CVC* system can handle any size TV tube currently produced. Interchangeable diffusion pump jet assemblies permit easy adaptation to the higher vacuums probably required for color TV tube aluminizing. The system is available *with* or *without* valves.

For smaller scale operations, *CVC* offers an integrated system of one to six individual pumping units with common roughing manifold and individual holding pumps. Timing devices control cycling automatically and permit one operator to handle all systems.

CVC's vast experience in designing inline exhaust systems makes these units trouble-free and economical in operation. We will be pleased to give you the details on specifications, costs, and deliveries. *Consolidated Vacuum Corporation, Rochester 3, N. Y.* (a subsidiary of Consolidated Engineering Corporation, Pasadena, California).

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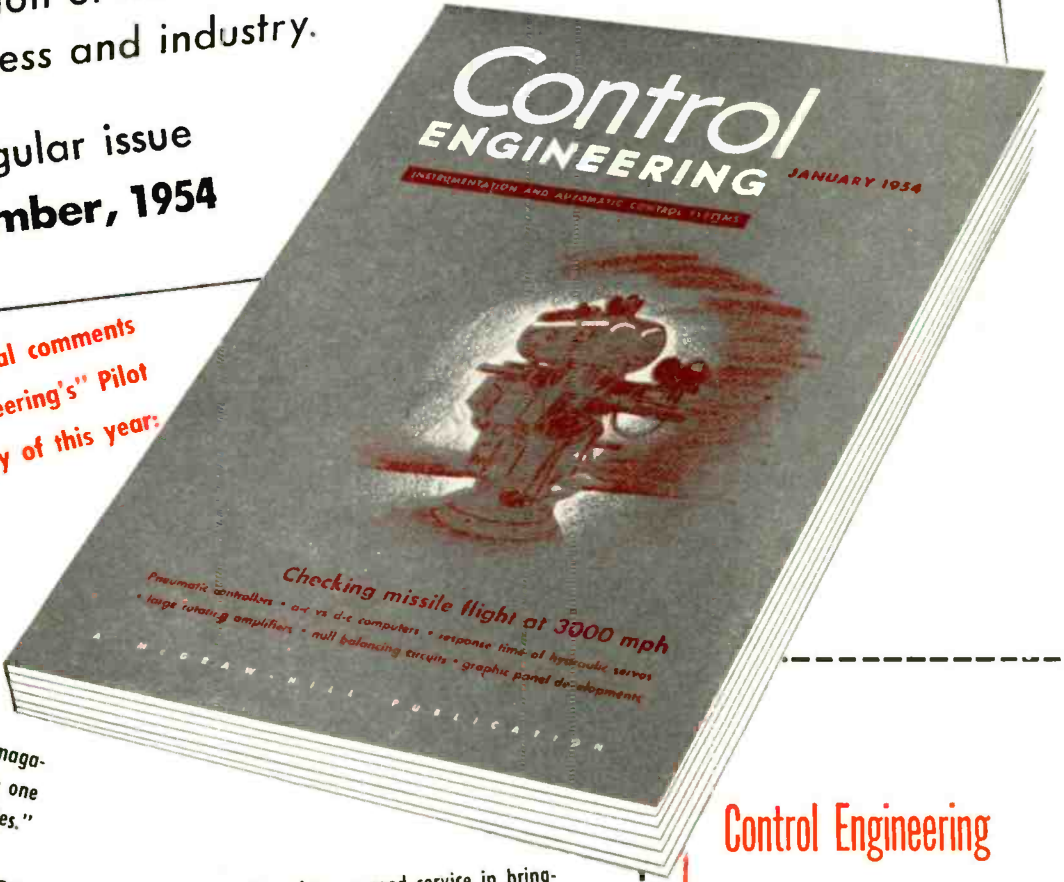
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Here are some of the typical comments received on "Control Engineering's" Pilot Issue published in January of this year:

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Since 1944, McGraw-Hill has been conducting a series of market analyses to determine editorial scope, circulation and advertising potentials for a magazine serving this field. The most recent of these studies, conducted early in 1953, indicated a strong current need for such a magazine among design engineers and technically trained management men in a broad range of industries.

Accordingly, in January, 1954, the first pilot issue of Control Engineering was published. Field surveys indicated an enthusiastic reception on the part of the men it was designed to serve. Many letters were also received praising its editorial scope and usefulness. Strong advertising support was voiced by leading manufacturers of instruments and control devices.

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System-Engineering

Associate Editor William E. Vannah, a specialist in the function of instrumentation in plant dynamics and contemporary instrument and system design, was associated for the past five years with the Research and Development Division of Foxboro Instrument Company.

Mathematician-Editor

George A. W. Boehm, formerly science editor of Newsweek, a mathematician and specialist in interpreting current technical developments, has been appointed Managing Editor of Control Engineering.

Servo-Technology

Associate Editor Byron K. Ledgerwood, formerly an editor of Product Engineering, specialized in reporting on servomechanisms in machine and system design.

Process Control

Business Editor Lloyd E. Slater, former Industry Manager at Minneapolis-Honeywell and Associate Editor of Food Engineering, specialized in development and application of automatic controls in processing.

Computer-Engineering

Assistant Editor Edward J. Kompass, formerly with The de Florez Company, Inc., is skilled in the design and development of digital computer technology.

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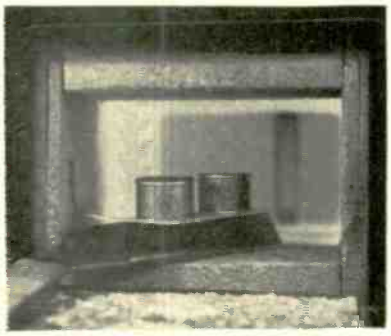
McGRAW-HILL PUBLICATIONS

Cylinders are coated with flux and silver rings and silver solder wire positioned on either end



Assembled rings are brazed about 60 sec in an oven heated to 1,450 F, then quenched

Brass ring is knocked out with series of short, sharp blows. This is a critical operation; the annealed copper crumples if hit too hard

attachment rigged on a horizontal mill, first on one edge, then the other. Afterward, each strip is put through a special roller that gives the necessary set to the fingers to insure good contact.

The contact itself is formed by

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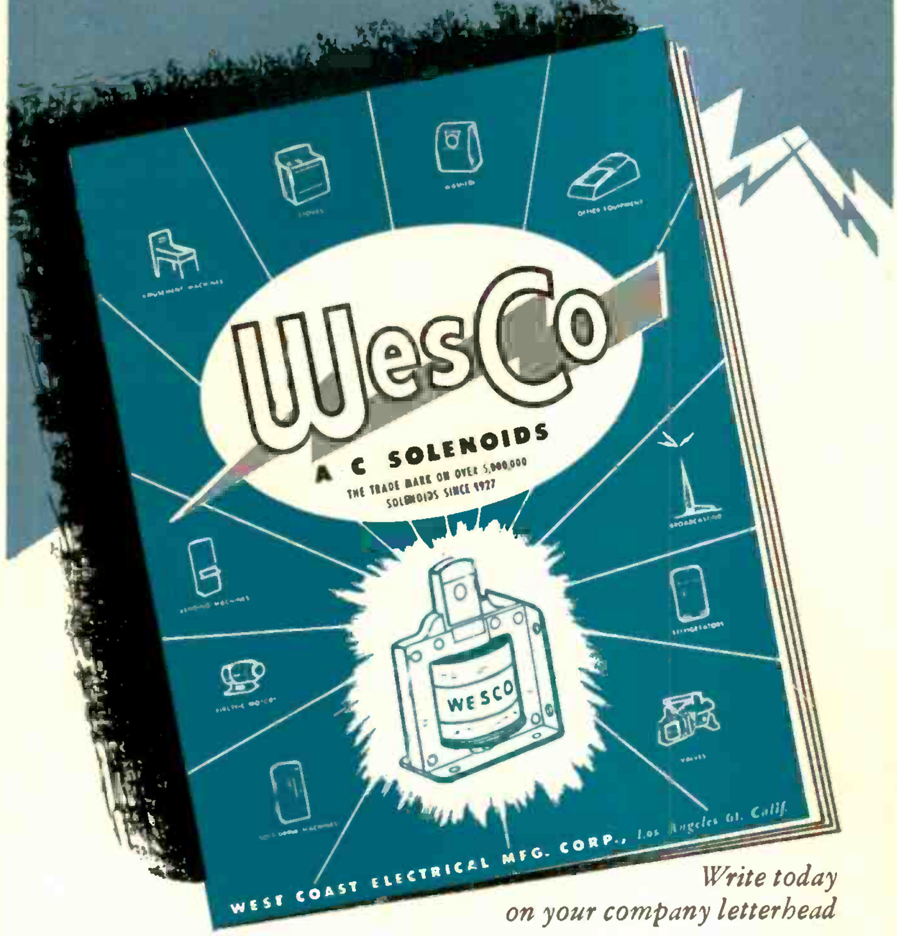
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NEW

TUBE ACCESSORIES
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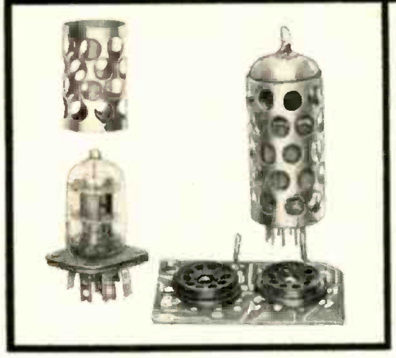
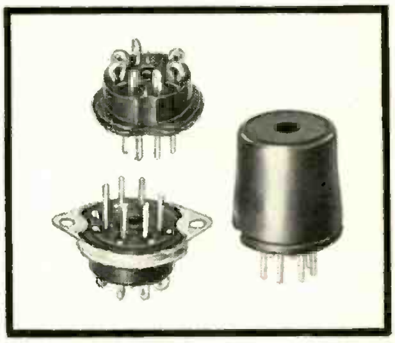
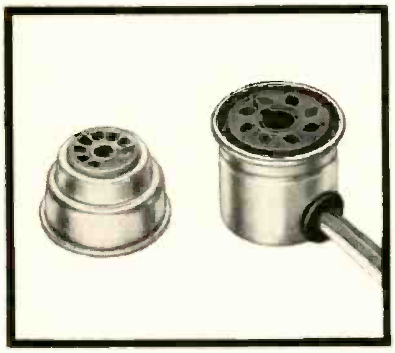


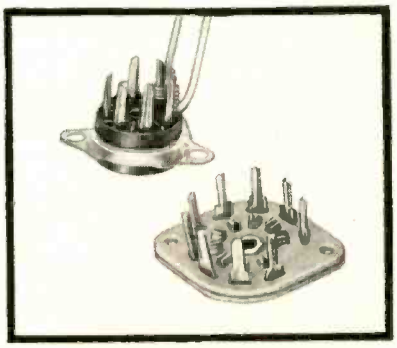
"Ventilator" shields not only improve "hot" tube performance by dissipating heat but are the most economical shields in Methode's extensive line. Easily handled and compression fitted to ground terminals on Methode laminated or printed circuit sockets, shields are available in lengths of 1-11/16" or 2-1/16" with one standard diameter which fits either seven or nine pin tubes. Available with tin or black oxide finish.



Molded phenolic plugs, with seven pins, 45° apart on .375" centers, mate with economical standard miniature sockets. Designed to save space and competitive in price with bulky wafer pin plates, these units are ideal for base assemblies on plug-in components or quick-disconnect harness assemblies. Plugs are available with or without vinyl caps or mounting saddles. General purpose or mica phenolic insulators with cadmium plated brass pins are standard.



For high voltage tubes these corona caps and socket combinations for both octal and noval sizes feature generously rolled outer surfaces. Assemblies are designed for screw mounting to condenser studs or stand offs and are available with general purpose black or low loss mica phenolic insulators. Noval caps available with 1-5/16" or 1-1/2" major rim diameter. Octal units have insulating fibre liners.



"Wire Wrap" sockets have terminals adapted for high speed solderless attachment of leads at considerable savings in assembly and inspection time. Miniature seven and nine pin units available in both laminated and molded types.

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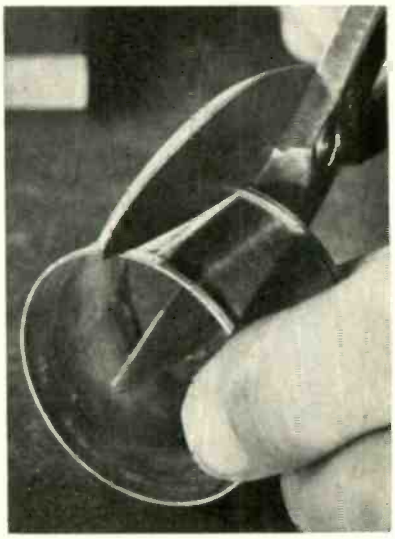
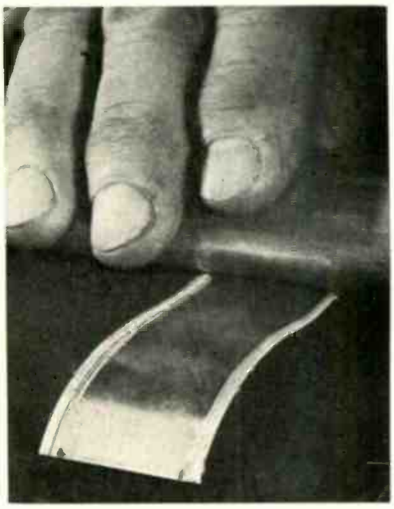
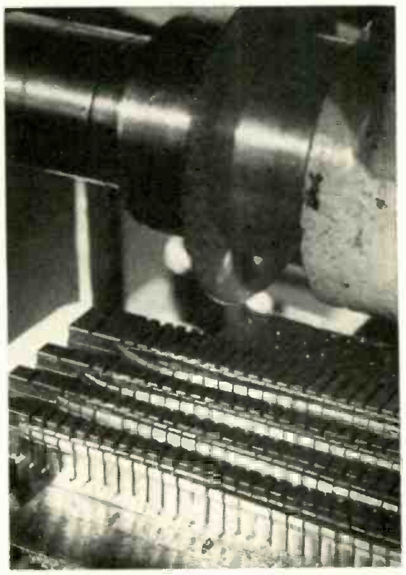


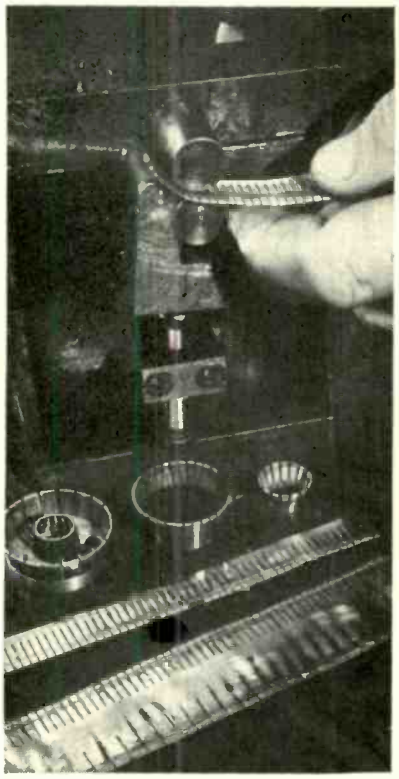
Silver rings are cut at unjoined seam of copper strip with tin snips



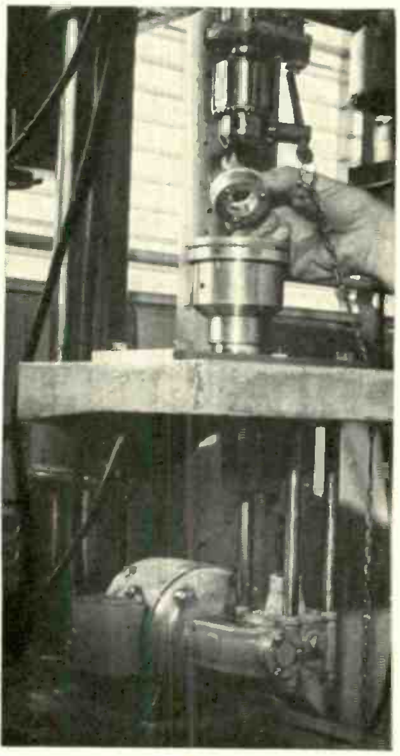
Silver rings are rolled flat with solid metal rolling pin



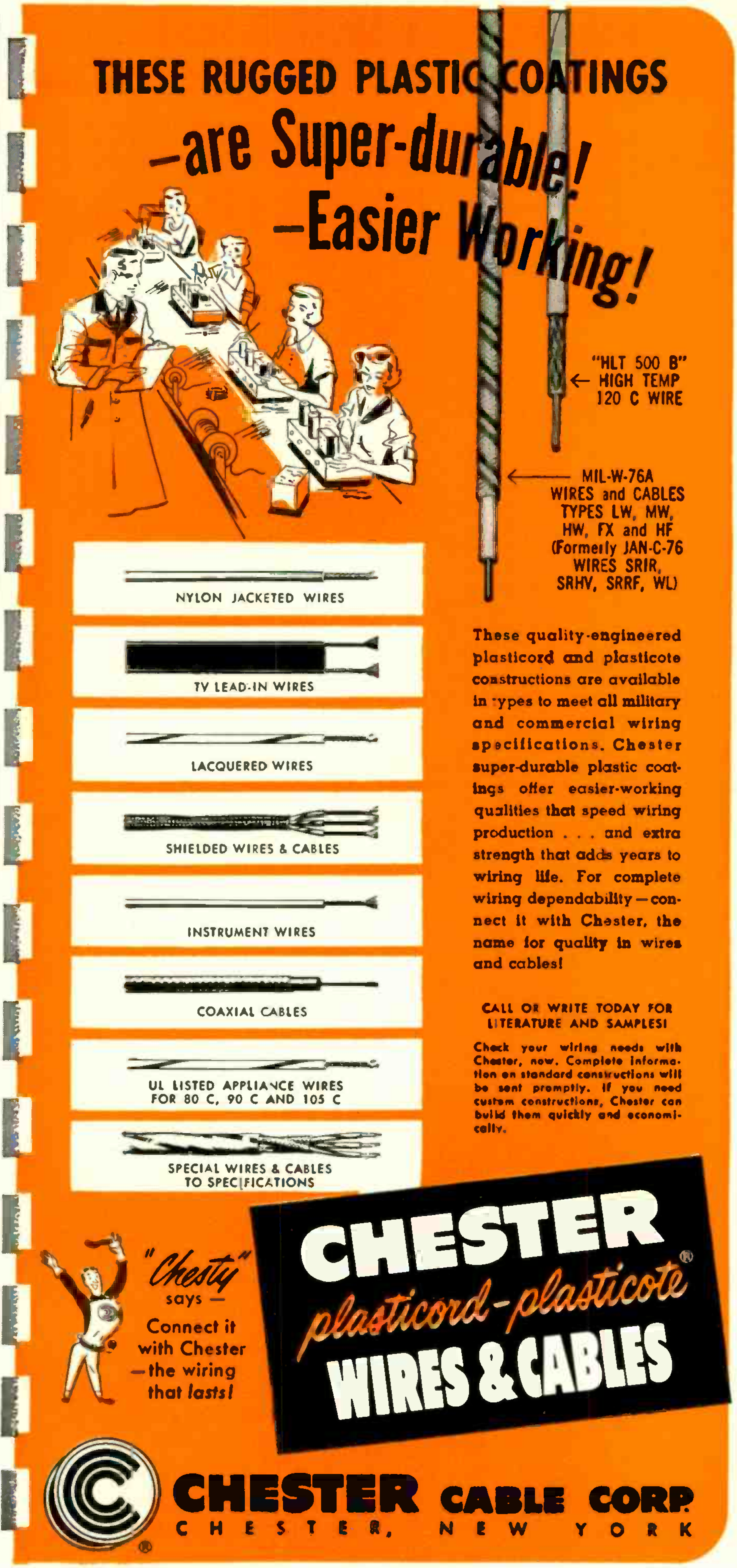
Eight of the strips are grouped together, two by two, in a packing fixture. The whole pack is slotted top and bottom by a saw attachment rigged on a horizontal mill



Each strip is cut longitudinally, then trimmed to size and put through another roller to shape it for assembly into a simple brass ring. Various types of contacts are made from the basic strips after this cutting operation



A conventional Delta drill press was adapted to lap inner and outer surfaces of contact fingers with simultaneous rotary and up-and-down motion. Reciprocating unit below table gives oscillatory up-and-down motion to specially fabricated carborundum wheel



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MIL-W-76A WIRES and CABLES TYPES LW, MW, HW, FX and HF (Formerly JAN-C-76 WIRES SRIR, SRHV, SRRF, WL)

NYLON JACKETED WIRES
TV LEAD-IN WIRES
LACQUERED WIRES
SHIELDED WIRES & CABLES
INSTRUMENT WIRES
COAXIAL CABLES
UL LISTED APPLIANCE WIRES FOR 80 C, 90 C AND 105 C
SPECIAL WIRES & CABLES TO SPECIFICATIONS

These quality-engineered plasticord and plasticote constructions are available in types to meet all military and commercial wiring specifications. Chester super-durable plastic coatings offer easier-working qualities that speed wiring production . . . and extra strength that adds years to wiring life. For complete wiring dependability—connect it with Chester, the name for quality in wires and cables!

CALL OR WRITE TODAY FOR LITERATURE AND SAMPLES!

Check your wiring needs with Chester, now. Complete information on standard constructions will be sent promptly. If you need custom constructions, Chester can build them quickly and economically.

"Chesty" says — Connect it with Chester —the wiring that lasts!

CHESTER® plasticord-plasticote WIRES & CABLES

CHESTER CABLE CORP.
CHESTER, NEW YORK

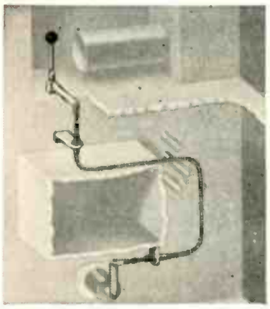
WHICH OF THESE CHARACTERISTICS ARE ESSENTIALS ON YOUR REMOTE CONTROL JOBS?

Accuracy . . . High Load Capacity . . . Adaptability . . . Freedom from Trouble . . . Long Life . . . Flexibility . . . these are some of the qualities of **ACCO TRU-LAY PUSH-PULL FLEXIBLE CONTROLS** that have made it possible to improve the operation of literally hundreds of mechanical products (list on request). Full description of this versatile REMOTE CONTROL is given in our **DATA FILE** available for your further study.

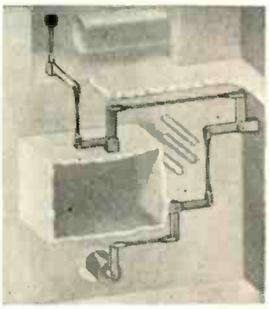
ACCURACY is inherent in the basic design, and in the standards of quality and precise dimension that control the manufacture of TRU-LAY PUSH-PULL CONTROLS. These are precision products, not gadgets.

VERSATILITY of this fine remote control can best be illustrated by citing some of the jobs it handles well . . . **HOT** jobs on jets and industrial furnaces . . . **COLD** jobs down to —70° F. . . . **WET** jobs (the conduit can be completely immersed) . . . **DIRTY** jobs . . . **ABRASIVE** jobs . . . **CORROSIVE** jobs . . . **HEAVY, TOUGH** jobs up to 1,000 lbs input . . . **LIGHT DUTY** jobs . . . **REMOTE** jobs 150 feet or more from the control point . . . these units are frequently and successfully used in conjunction with electric, hydraulic and air controls . . . are thoroughly effective under almost any operating condition.

"SOLID as a rod but FLEXIBLE as a wire rope" aptly describes TRU-LAY PUSH-PULL CONTROLS. This *flexibility* provides positive, remote action whether anchorages are fixed or movable . . . it damps out noise and vibration—protects delicate instruments . . . it permits ease of handling and shipping even when assemblies are 100 or 150 feet long . . . it avoids the risk of damage always present with solid tubular controls that must be preformed to position . . . and flexibility greatly simplifies installation of controls by reducing the number of working parts and by making it possible to snake around obstructions. . .



to give you this simple and effective assembly



. . . rather than this complex (and expensive) series of linkages

ADAPTABILITY to all sorts of mechanical situations explains, in large measure, the wide-spread application of TRU-LAY PUSH-PULLS. Standard anchorages, fittings and heads have been designed that meet requirements on approximately 80% of the installations. Simple modifications of these standards, or minor changes in your own design, cover almost every special situation. Our engineers have the know-how on such matters.

FREEDOM FROM TROUBLE and **LONG LIFE** are assured even under exceptionally adverse operating conditions because of such things as . . . full protection of the flexible, inner, working member by the tough flexible conduit . . . lubrication of the inner, working member *for life* during assembly . . . seals that keep moisture, dust and other foreign matter out of the unit . . . cold swaging of fittings that makes them integral parts of the control unit. (Full construction details in our **DATA FILE**). We have never heard of a TRU-LAY FLEXIBLE PUSH-PULL CONTROL wearing out in normal service.

Whether your interest is in a single application of this versatile PUSH-PULL CONTROL, or in its inclusion as a component of the product you manufacture, the six booklets and bulletins in this **DATA FILE** will answer your further questions, and will also provide you with the means of defining to us the application you may be interested in.

DATA FILE

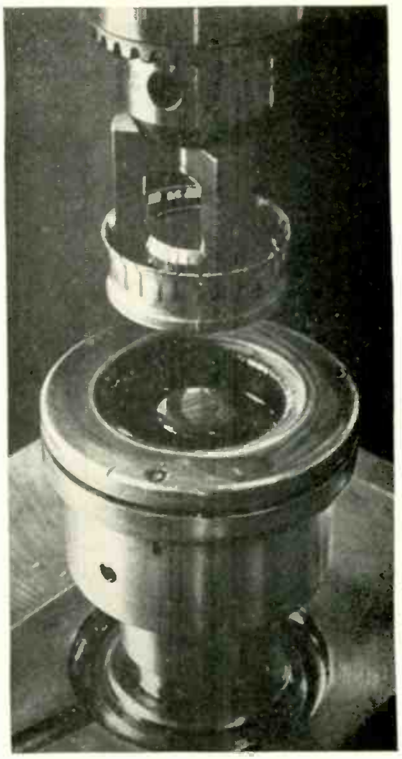
WRITE for a copy, without obligation

ACCO

AUTOMOTIVE and AIRCRAFT DIVISION
AMERICAN CHAIN & CABLE

TRADE MARK

601-B Stephenson Bldg., Detroit 2 • 2216-B South Garfield Ave., Los Angeles 22
929-B Connecticut Ave., Bridgeport 2, Conn.



Lapping operation takes about 10 minutes on modified drill press

assembling each strip into a simple brass ring, and placing this assembly in a furnace to harden the fingers for proper spring action.

The strip is then soldered to the brass ring and the contact lapped inside and out to achieve proper surface contour for the silver overlay contacts.

An adapted drill press does a double lapping job, finishing the inner and outer surfaces of the contact fingers with a simultaneous rotary and up-and-down motion. A drill press chuck holds the contact for the rotary motion; an oscillatory up-and-down motion of the specially fabricated lapping stone is obtained by addition of a reciprocating mechanism.

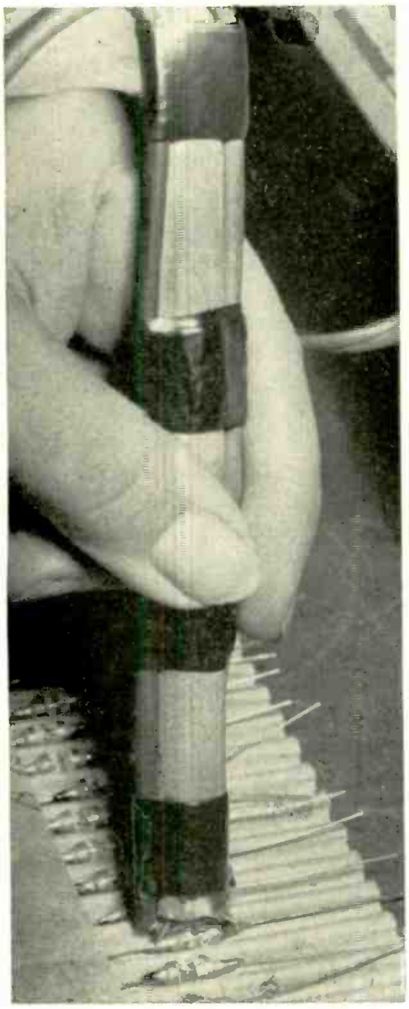
The lapping operation takes about 10 minutes, with the drill press rotating 5 minutes clockwise and 5 minutes counter-clockwise.

Previously the lapping was done by hand, using Bon Ami as a cutting compound. The operation was time-consuming—15 to 20 minutes —and wasteful, since the delicate fingers could easily be damaged by even a highly skilled worker.

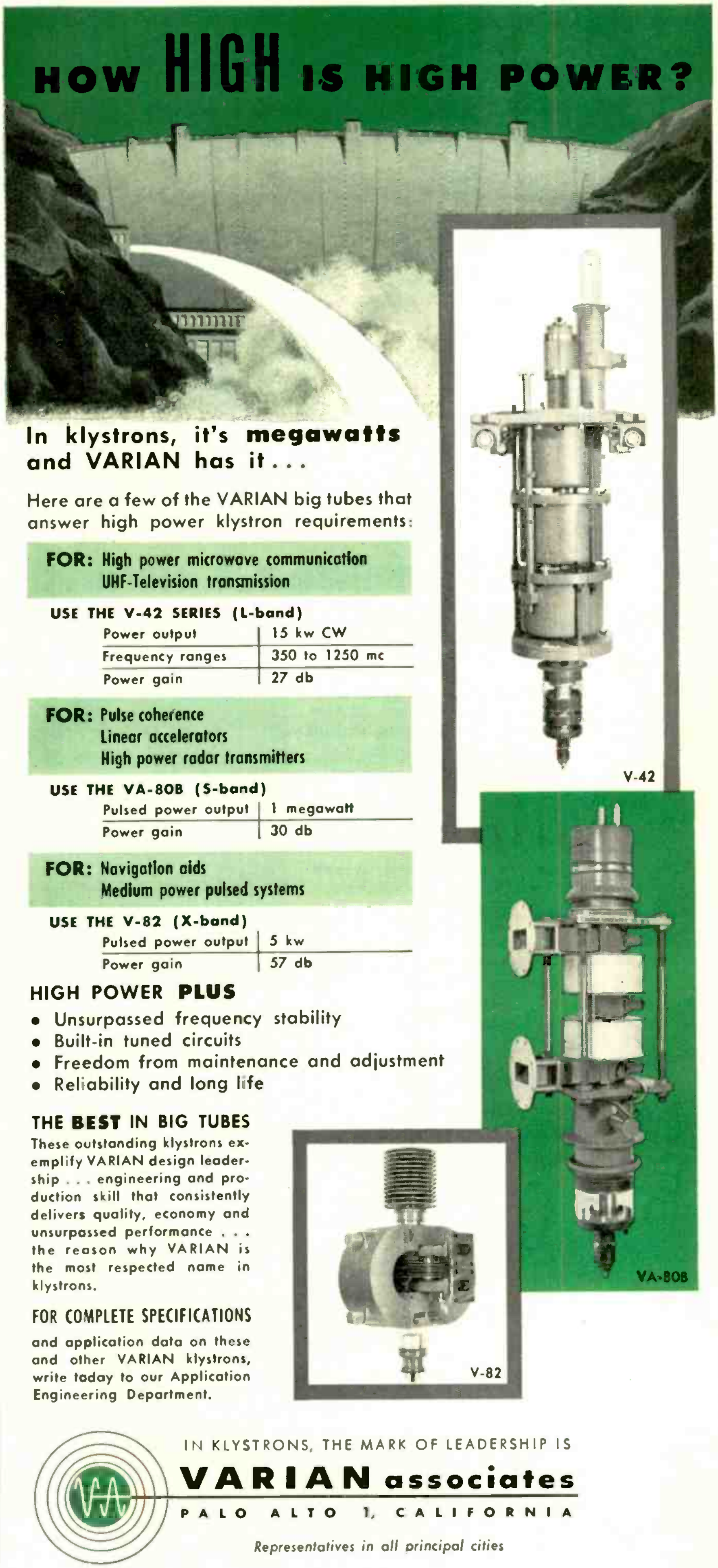
Contacting-type shorts have been used in many instruments that operate at high frequencies. These shorts have been found superior to the choke types in general use, especially in broadband equipment. The contacting short can be designed to be effective with a high vswr and no resonances over wide frequency ranges. Further, life tests of 100,000 cycles show no significant wear. In contrast, the choke type plunger must often be designed with very close tolerances, and when used with extruded waveguide sections these tolerances usually become meaningless.

Two-Contact Test Prod for Germanium Diodes

CONNECTIONS to both leads of a germanium diode are made simultaneously with a simple test prod improvised by the test department of Amperex Electronic Corp., Hicksville, N. Y. The two test leads are taped to opposite sides of a half-inch wood dowel rod. Metal



Details of improvised two-contact test prod for diodes



HOW HIGH IS HIGH POWER?

In klystrons, it's **megawatts** and VARIAN has it . . .

Here are a few of the VARIAN big tubes that answer high power klystron requirements:

FOR: High power microwave communication
UHF-Television transmission

USE THE V-42 SERIES (L-band)

Power output	15 kw CW
Frequency ranges	350 to 1250 mc
Power gain	27 db

FOR: Pulse coherence
Linear accelerators
High power radar transmitters

USE THE VA-80B (S-band)

Pulsed power output	1 megawatt
Power gain	30 db

FOR: Navigation aids
Medium power pulsed systems

USE THE V-82 (X-band)

Pulsed power output	5 kw
Power gain	57 db

HIGH POWER **PLUS**

- Unsurpassed frequency stability
- Built-in tuned circuits
- Freedom from maintenance and adjustment
- Reliability and long life

THE **BEST** IN BIG TUBES

These outstanding klystrons exemplify VARIAN design leadership . . . engineering and production skill that consistently delivers quality, economy and unsurpassed performance . . . the reason why VARIAN is the most respected name in klystrons.

FOR COMPLETE SPECIFICATIONS

and application data on these and other VARIAN klystrons, write today to our Application Engineering Department.

V-42

VA-80B

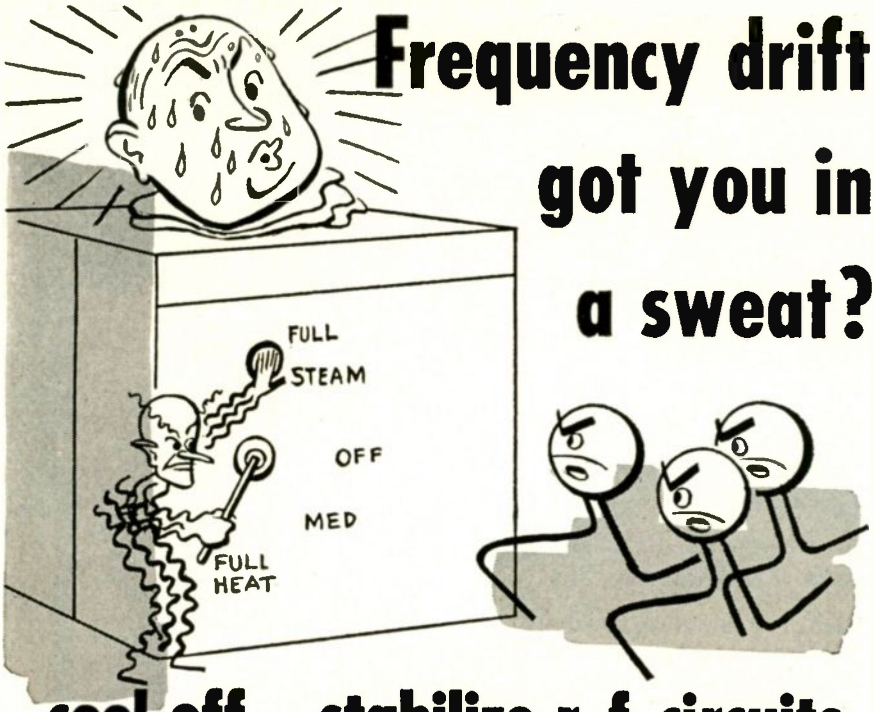
V-82

IN KLYSTRONS, THE MARK OF LEADERSHIP IS

VARIAN associates

PALO ALTO 1, CALIFORNIA

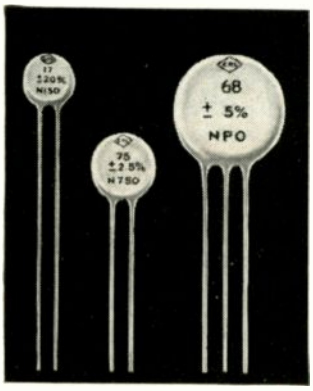
Representatives in all principal cities


Frequency drift got you in a sweat?
FULL STEAM
OFF
MED
FULL HEAT

cool off...stabilize r. f. circuits with Centralab TC disc capacitors

If frequency drift plagues you, let Centralab TC discs come to the rescue. Here are good reasons why you should use CRL TC discs in your circuits:

- **TC characteristics** from NPO to N750. Capacities from 5 to 225 mmf.
- **Four sizes:** ¼", ⅜", 5/16" and ⅝" diameter — all sizes .156" max. thickness.
- **Standard ratings and tolerances** in accordance with JAN and RETMA.
- **Insulation resistance:** 10,000 megohms or greater.
- **Capacitance tolerances:** ± 20%, ± 10% and ± 5%.
- **Power factor:** .1% maximum at 1 mc; .2% maximum after 100 hours at 95% relative humidity 40°C.
- **Voltage rating:** 500 vdcw; 1500 vdc test.



TC discs plainly marked
Discs are stamped with capacitance value, tolerance and nominal TC characteristic. The ¼"-diameter discs are color-coded to RETMA standards. Helps speed assembly.

Standard items available at your local (CRL) distributor — see Catalog 29.

Keep cool — call on Centralab for a solution to all your capacitor problems

- CRL has the largest staff of development engineers of any comparable company . . . over 150 technicians available for engineering assistance.
- CRL's many plants are highly mechanized for efficient, quality manufacture and are strategically located for fast delivery.

Write now for bulletin EP-17

Centralab

A Division of Globe-Union Inc.
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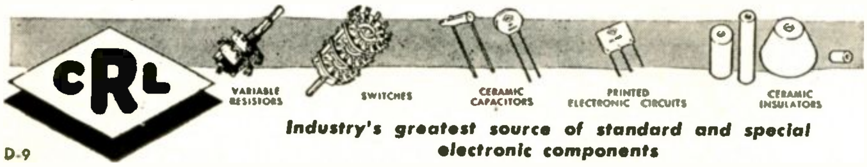


Industry's greatest source of standard and special electronic components

D-9

Setup for checking diodes that are still in their corrugated shipping tray

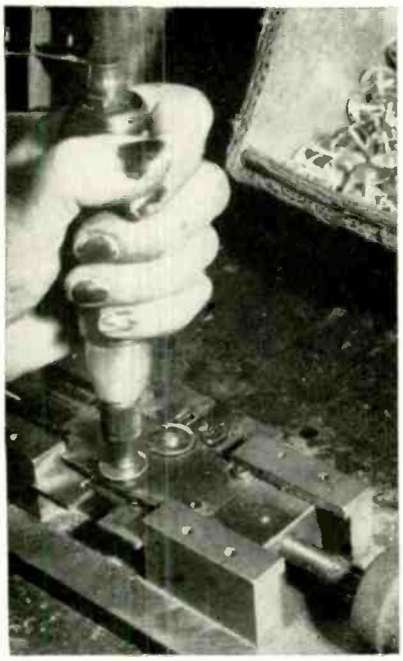
clips soldered to the ends of the leads are spaced apart the exact length of Amperex type 1N38A germanium diodes, so that the operator merely needs to press the prod over a diode to make both connections. Characteristics are then read on a GE germanium diode checker.

Driving Trimmer Screws in Printed I-F Transformers

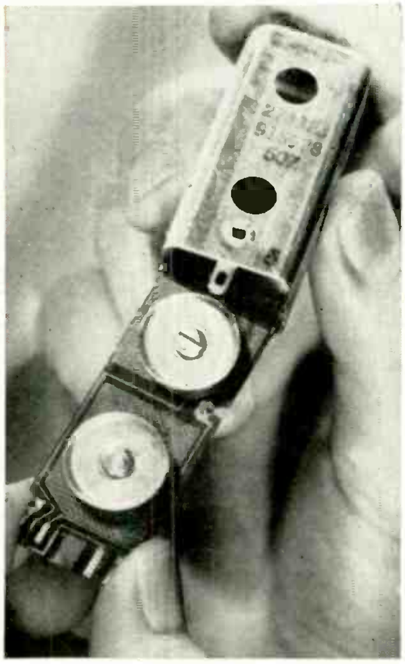
DRIVING of self-tapping screws for mounting trimmer-disc heads is combined with rough adjustment to inductance through use of an air-powered screwdriver and an air-actuated combination vise and jig in one plant. The setup speeds assembly of etched i-f components for television receivers.

The operator places a strip in the fixture with the etched coils facing upward. Next, she places an insulating washer in position over the plate coil and operates a foot pedal to close the vise over the strip. This brings steel plates inward to meet and form two holes into which the operator inserts the self-tapping trimmer screws. She then uses a Keller Tool Co. air driver for running these screws into punched holes in the plastic strip until the trimmer discs are stopped by the steel positioning blades of the vise. Another push of the foot pedal retracts the vise jaws so that the part can be removed to complete the operation.

The coil strip is next inserted in



Using air driver and depth-controlling vise jaws to speed assembly of etched i-f coil strips



Method of inserting strip in shield can

its drawn aluminum can, which has length-wise grooves that position and grip the strip so no fasteners are needed.

Combination grounding and mounting lugs are staked to opposite sides of the shield cans when the components are to be assembled into a video i-f strip by dip soldering. These lugs fit into punched slots in the etched i-f circuit strip, in such a way that dip soldering of

RELAY PROBLEMS

on your mind?

turn the problem over to

COMAR

Solving tough relay problems is our business. If you have a relay problem on a product currently in production, or one in the development stage, we believe we can save you a lot of headaches. For example, modifying an existing Comar design to fit your needs may save you substantial engineering and tooling costs. Or, if you require special design, we have complete facilities to custom-engineer relays to suit your specifications.

COMAR ENGINEERS WILL HELP YOU

Whether your relay problems are simple or complex, you'll save time and money by contacting Comar. Inquiries invited. No cost or obligation for consultation and our recommendations.

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CHICAGO 18, ILLINOIS

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TANTALUM CAPACITORS...

...basic in current electronic trend..

ACTUAL SIZE
1.75 mfd. to 575 mfd.

- Premium Performance and Life
- Minimum Space per Mfd.
- Wide Temperature Limits
- Infinite Shelf Life
- Proven Reliability Since 1930

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TANTALUM CAPACITORS

Now, through the use of tantalum, new high standards of electrolytic capacitor performance are available. The tantalum oxide film is the most stable dielectric, chemically and electrically, yet discovered. As a result, Tantalum Capacitors offer advantages not found in any other electrolytic type — long life, space saving, wide temperature range excellent frequency characteristics, no shelf aging.

Tantalum Capacitors are made by Fansteel and other leading capacitor manufacturers. Ask for current information bulletins on Fansteel Tantalum Capacitors.

Fansteel TANTALUM CAPACITORS

FANSTEEL METALLURGICAL CORPORATION
NORTH CHICAGO, ILLINOIS, U. S. A.
Tantalum Capacitors... Dependable Since 1930

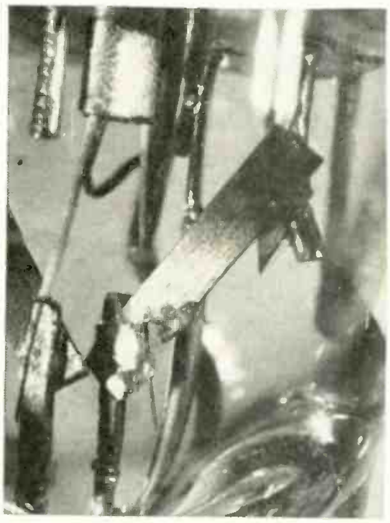
32503C

the entire panel solders the lugs to the etched wiring for simultaneous mounting and grounding.

Tube Inspection Program for Airborne Equipment

By B. A. KLEINHOFER
Supervisor, Electronic Engineering
North American Aviation, Inc.
Downey, California

AN ELECTRON-TUBE inspection program instituted in November 1951 has given greater assurance that nondefective tubes would be used in the airborne navigation and control equipment in various phases of development and production.



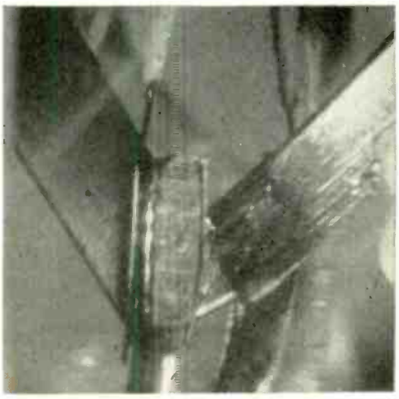
Microscopic inspection revealed melted band supporting tube elements along with tag remnant of unsuccessful attempt to weld band to stake. Such fragments are allowable only if firmly anchored and adequately clear of other electrodes

Incoming electron-tubes are approved on a sampling basis. There must be lot approval and acceptance by the sampling techniques for the military to be assured that average overall quality is maintained; however, little is indicated about individual tubes. A certain percentage of inoperable tubes is therefore accepted.

When these inoperatives are economically rejected from the lot so as not to be stocked and installed in developmental or production equipment, valuable developmental and production-test time is saved. There are also other tubes in the lot which are believed to be potentially defective and should be omitted from airborne installations.

The approach to the problem of

establishing appropriate inspection tests has been to study tube designs and procurement specifications, note departures from intended design or assembly and evaluate the effect of these departures on the reliability of tubes. To date, about 33,000 low-power receiving and transmitting tubes have been inspected by microscopic, polariscopic and radiographic techniques.

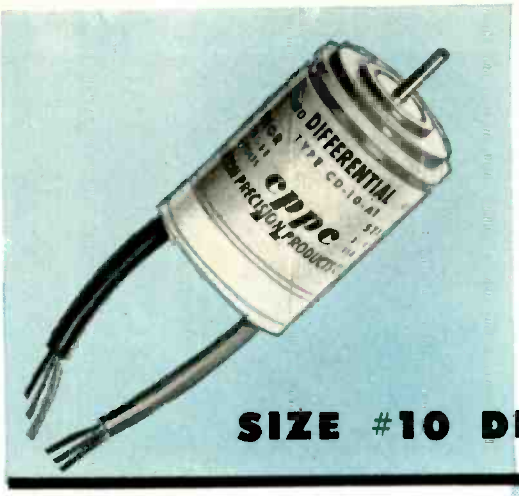


Microscopic inspection here reveals possible poor bond between tungsten heater wire and the nickel alloy strap and copper lead. Normally, the tungsten is embedded in the other element by electrode pressure; absence of such deformation can mean that the wire is only lightly stuck and may come loose with vibration

An adjunct to microscopic inspection is x-ray inspection. The tubes are x-rayed in two positions, with the element supports parallel and perpendicular respectively to the plane of the film.

To obtain maximum radiographic definition and contrast, experimentation is required to determine the material, if any, that is permissible between the tube to be x-rayed and the unexposed film, the distance between the x-ray source and the tube, the focal spot size of the anode, the anode voltage, the exposure time in milliampere-seconds, and the types of film and developer. Experimentation shows that there are only about twelve basic sets of settings for x-raying more than a hundred types of tubes.

Since the MIL-E-1B ice water test is inconvenient for testing all tubes, polariscopic examination was preferred and is believed to provide adequate protection (RETMA report, March 1951, "A Method for Measuring Strain in Side Walls of



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HIGH

ACCURACY

SIZE #10 DIFFERENTIAL...

Better than Size #15 accuracy (10′ rotor and 15′ stator total error spread), at a saving of more than half the size and weight is obtainable in this Size #10 unit, and at a comparable price.

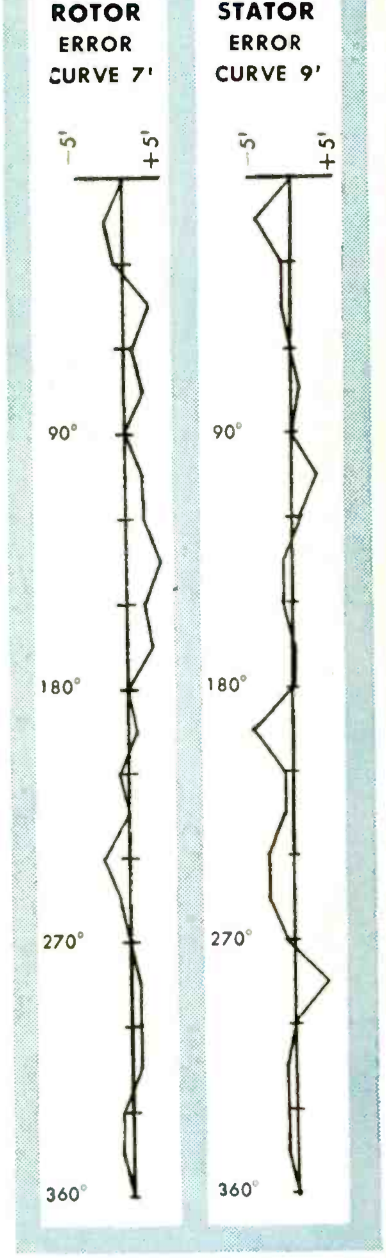
Product of the same engineering team that designed and put into production the precision Size #15 synchro—it is one of a complete line of high accuracy .937″ diameter synchros immediately available on a production basis.

- Clamped bearings
- Tested to 550V a.c

SYNCHRO PROGRESS

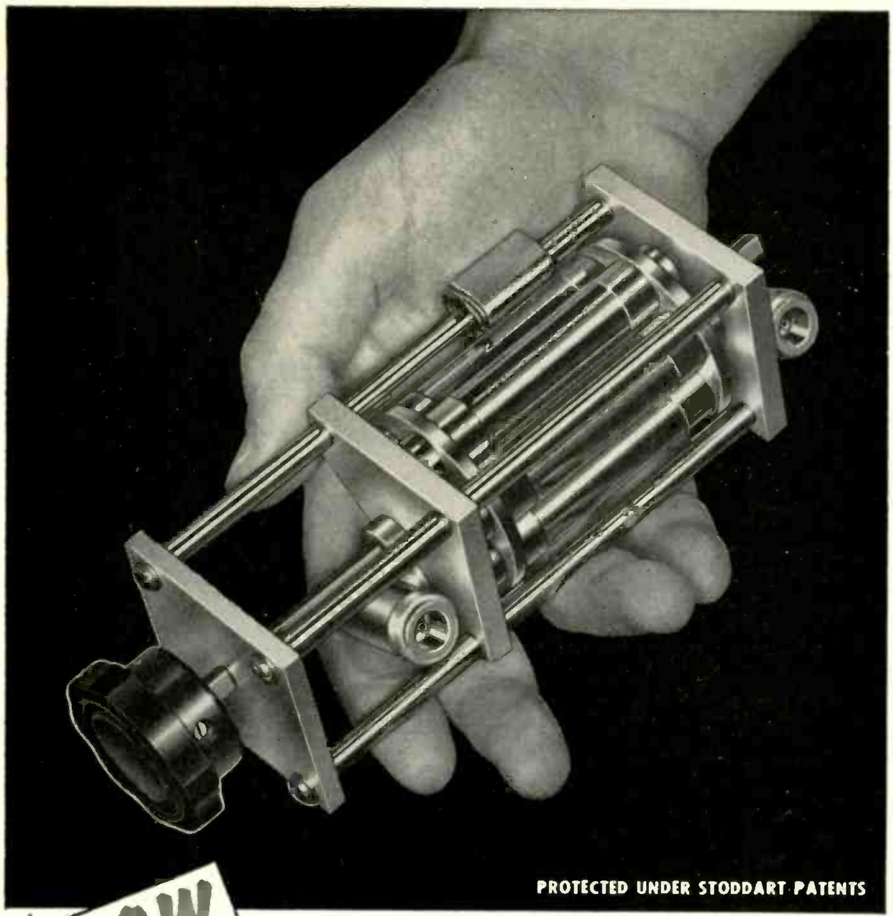
Year	Error Spread	Weight	Cost
1917	6°	5 lbs.	? Marks
1934	6°	10 oz.	$65.00
1941	2½°	5 oz.	$20.00
1944	20′	5 oz.	$35.00
1954	10′	1¾ oz.	$25.00
Coming	5′	5 oz.	?

For full information on these and other units, write or telephone A.E. Hayes, Sales Dept. (Phila.) MAdison 6-2101. West Coast Rep., Wm. J. Enright, 988 W. Kensington Rd., Los Angeles 26, Calif. MUtual 6573



cppc

CLIFTON PRECISION PRODUCTS COMPANY, INC.
CLIFTON HEIGHTS, PENNSYLVANIA



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Precision Attenuation to 3000 mc!

TURRET ATTENUATOR featuring "PULL-TURN-PUSH" action

SINGLE "IN-THE-LINE" ATTENUATOR PADS and 50 ohm COAXIAL TERMINATION

FREQUENCY RANGE:
dc to 3000 mc.
CHARACTERISTIC IMPEDANCE:
50 ohms
CONNECTORS:
Type "N" Coaxial female fittings each end
AVAILABLE ATTENUATION:
Any value from .1 db to 60 db
VSWR:
<1.2, dc to 3000 mc., for all values from 10 to 60 db
<1.5, dc to 3000 mc., for values from .1 to 9 db
ACCURACY:
±0.5 db
POWER RATING:
One watt sine wave power dissipation

Send for free bulletin entitled "Measurement of RF Attenuation"

•

Inquiries invited concerning pads or turrets with different connector styles

STODDART AIRCRAFT RADIO Co., Inc.
6644-A Santa Monica Blvd., Hollywood 38, California • Hollywood 4-9294

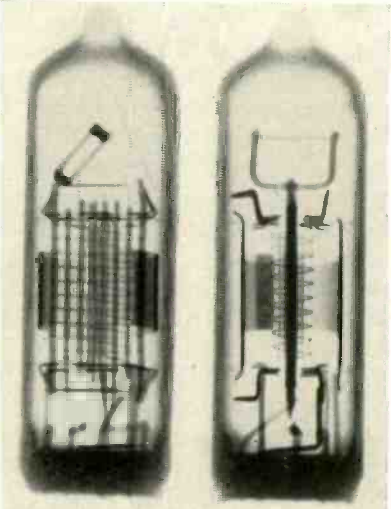
10 DB 50 OHMS
90500-10 ATTENUATOR
STODDART AIRCRAFT RADIO CO.
HOLLYWOOD 38, CALIF.
90550-1
COAXIAL LINE TERMINATION
50 OHMS

Microscopic inspection here indicated that excessive welding heat formed support rod into a tear drop, impairing tube reliability

Glass Bulbs and Completed Tubes"). Values for allowable stress are determined empirically from laboratory breakage tests.

Tubes are color-coded with a blue tip when they meet all inspection criteria, and with a yellow tip when they have assembly irregularities. Percentage rejection rates for the various examinations are: microscope 17 percent; x-ray 17 percent; polariscope 4 percent; vibration 2 percent; electrical 8 percent. Many tubes exhibit several irregularities, hence the yield of tubes coded blue is 66 percent and yellow 26 percent.

Tubes coded blue are reserved for critical installations. Tubes coded yellow are for use in controlled tests, in noncritical installations, at the discretion of the project engineers



Typical x-ray inspection slides obtained for a good subminiature tube and in laboratory equipment development where shock and vibration are not problems.

As quality is improving and as more and more premium-type tubes are being received, the yield of flawless tubes by the inspection is increasing. During December, 1953, for example, the yield of flawless tubes for critical installations was 77 percent (for 6,600) as compared with 66 percent for the total 33,000 tubes. For subminiature tubes of one manufacturer, for the same month, the yield was 87 percent. Further improvement in yield is expected with the new military-control miniature types which are now just in production.

The inspection does not constitute selection in the sense to which the armed services are opposed, for the use of the more rigidly inspected tubes in no way compromises the ability to replace field failures with standard military-approved tubes from stock without selection. The undesirable type of selection-inspection arises from unusual circuit requirements and is not included in the program.

Metal Embossing Machine Makes Identification Tags

EMBOSSED aluminum alloy tags for identifying components are produced at the rate of 90 per minute by a new Databosser model V100 DBM made by Dashew Business Machines, Inc., 1641 McGarry Street, Los Angeles 21, California.

Additional operations that can be

Applying wired embossed tags to electrolytic capacitors that are to be used in electronic control relay panels like those shown in the background. Other tags are used to identify the panel itself

Quick, dependable carrier measurements—3 to 500 kc

New Model 104 Carrier Frequency Voltmeter—5 to 150 kc

Four Frequency-Selective Voltmeters

Four precision frequency-selective voltmeters for carrier system measurements are now offered by Sierra. Including the new Model 104, these instruments cover all frequencies 3 to 500 kc. They provide a fast, accurate means of measuring voltages in telephone, telegraph, telemetering and control circuits. They also make possible quick, dependable tracing of circuit faults. All four instruments have direct reading meters calibrated in dbm from —20 to + 2 dbm on the meter and —60 to + 40 dbm on the range changing attenuator. All contain a built-in calibration oscillator and a VTVM for swift, simple calibration. **For details, request Bulletin 107.** *(For wave analysis and harmonic studies 15 to 500 kc, Sierra offers Model 121 Wave Analyzer. Request Bulletin 103).*

SPECIFICATIONS

Model No.	Frequency Range—kc	Input Level Range—dbm	Selectivity		Direct Reading in dbm	
			Down 3 db	Down 45 db	Balanced	Unbalanced
101A	20—500	—80 to + 42	± 750 cps	± 6000 cps	*	600 ohms
103A†	3—40	—80 to + 42	± 400 cps	± 3000 cps	**	600 ohms
104	5—150	—80 to + 42	± 300 cps	± 1500 cps	**	600 ohms
108A	15—500	—80 to + 42	± 600 cps	± 3000 cps	135 ohms*	600 ohms

*May be converted for 135, 500 or 600 ohm balanced line measurements with Sierra 122 Line-Bridging Transformer. (Low cost, plug-in unit). **Same as 101A except uses Model 155 Transformer. †Contains carrier re-insertion oscillator for monitoring single side band suppressed carrier systems. Data subject to change without notice.

sierra

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San Carlos 2, California, U. S. A.
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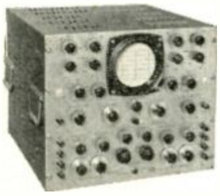
Manufacturers of Carrier Frequency Voltmeters, Wave Analyzers, Line Fault Analyzers, Directional Couplers, Wideband RF Transformers, Custom Radio Transmitters, VHF-UHF Detectors, Variable Impedance Wattmeters, Reflection Coefficient Meters.

3068

Simul-Scopic* Signals

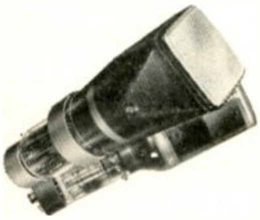
TAKE THE GUESSWORK OUT OF SCOPES

It's all done by combining any number of electron guns up to ten in a single cathode ray tube. Then, when you have to measure simultaneous phenomena, you've actually got a number of oscilloscopes in one—all operating continuously without the disadvantages of electronic-switching or an optical system. And only ETC multi-channel scopes and multi-gun tubes make Simul-Scopic signals available to meet such a wide variety of individual needs.



MULTI-CHANNEL SCOPES

. . . with the combination you need of band width, gain, sensitivity, frequency response, with or without film strip recording. Separate intensity, focus, and axes controls for each channel.



MULTI-GUN TUBES

. . . with 2 to 10 guns . . . round or square face . . . 3 to 12 inches. Special purpose tubes made to specification, including every type capable of commercial manufacture.

THIS FREE CATALOG

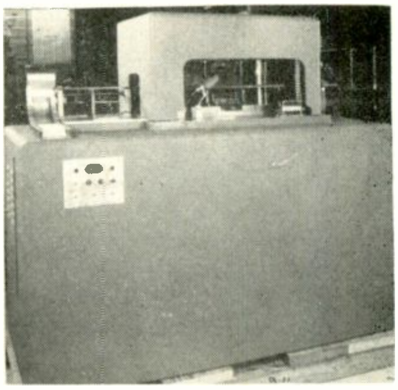
. . . entitled "Oscillography—Key To The Unknown", shows why there is no other equipment so easy to use, so comprehensive in its presentation, and so economically practical for simultaneous oscillography. Write for your copy.

***Simul-Scopic** — *Two or more simultaneous events which can be observed on a cathode ray tube (Reg. Applied for)*

ETC

electronic tube corporation

1200 E. MERMAID LANE, PHILADELPHIA 18, PA.



Tag-embossing machine. Blank tags are fed into machine at right and emerge in hopper tray at left

performed simultaneously with embossing include threading and twisting of wires into the tag holes, inking the embossed printing to increase readability and matching of the tags for special classification and coding purposes. An example of the use of the wired tags is identifying the parts for an electronic control relay panel in the stockroom and during assembly at Century Manufacturing Co., Los Angeles, Calif.

Room can be left on the embossed tags for later addition of inspection and quality control markings. These are applied with a fountain-type pen having a felt tip and containing an inky-black quick-drying chemical fluid.

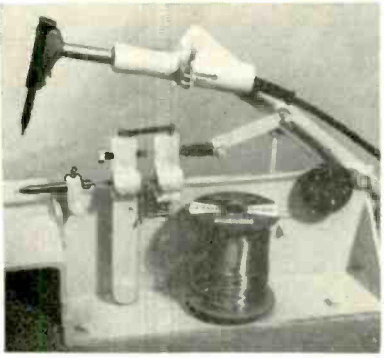
Once a tag is attached, it accompanies the part through all assembly and processing operations, including chemical cleaning baths. These have no effect on the ink markings or on the special 916 aluminum alloy used for the tag. The edges of each tag are automatically beveled by the machine to eliminate sharp points that might scratch people or parts.

The machine embosses with either repetitive or serial part numbers. The finished tags are depositioned in a receiving tray ready for use.

Automatic Solderer

REPETITIVE SOLDERING processes of small parts can be performed at high speed on a new Multicore automatic soldering head made by Multicore Solders Ltd., Maylands Ave., Hemel Hempstead, Hertfordshire, England.

Rosin-core solder drawn from a

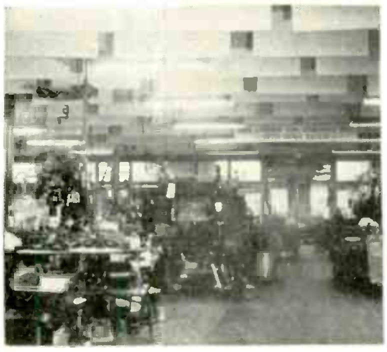


Automatic solderer. Each downward movement of soldering iron actuates solder feed through linkages. Amount of feed is determined by horizontal bolt which serves as stop for feed plunger

7-lb reel is automatically fed above the components to be soldered and an electrically heated iron automatically descends and solders the components held together on the anvil The machine will accommodate various diameters of solder. The amount of solder fed per operation is adjustable between $\frac{1}{32}$ inch and $\frac{1}{8}$ inch. One model of the machine is supplied without motive power, so that it can be linked with an existing manufacturing process. Another is supplied complete with a bench and a foot-operating pedal, while the third model is a motorized version which will make joints at the rate of up to 3,000 per hour.

Hanging Baffles Reduce Punch Press Noise

THE NOISE AND CLAMOR of machinery used in the plant of John Volkert Metal Stampings, Inc., Queens Village, N. Y. for producing precision metal stampings for the electronics industry has been reduced approximately 50 percent by installation of Fiberglas noise-stop baffles. These are rigid fibrous

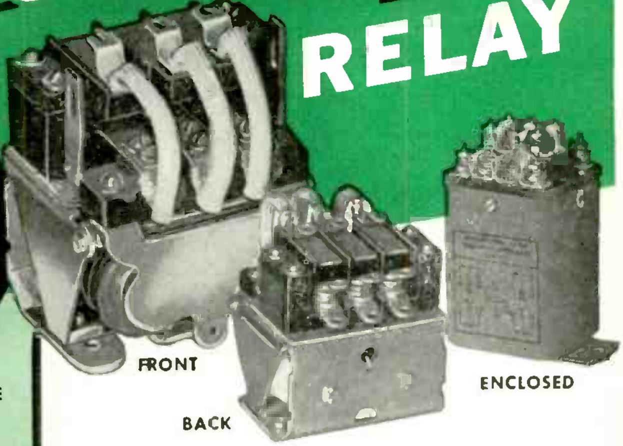


Method of installing ceiling baffles

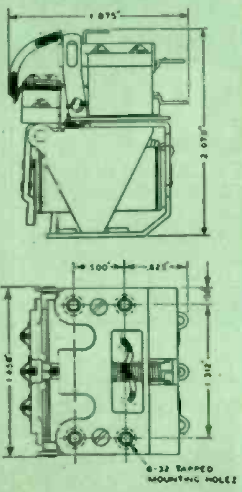
Where SHOCK and VIBRATION are a Problem . . .

ENGINEERS CHOOSE the rugged Phil-trol 27 RELAY

For AVIATION and ELECTRONIC INDUSTRIES



TYPE 27QA—3 POLE

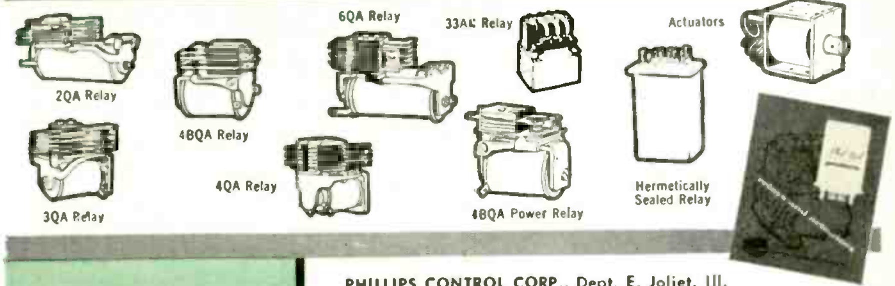


Phil-trol Type 27 Relays are available in 1, 2, 3, 4 or 5 pole, single or double throw. Operating voltage up to 230 D.C., resistance up to 13,400 ohms. minimum operating current is .001 amps. Available enclosed in dust cover or hermetically sealed.

■ Proved performance of Phil-trol 27 Relays in many vitally important applications has built great demand for this sturdy, sensitive and highly efficient relay. For instance, they are used for: propeller pitch control . . . cabin pressure and temperature control . . . guided missiles . . . computers . . . communication equipment . . . and many other electronic devices.

Phil-trol 27 Relays have unusual features like two-coil construction, which allows greater operating force for a given power input, and also completely eliminates magnetizing force losses at the armature hinge. The rigid frame and balanced armature design provides stability under conditions of high acceleration, severe vibration or shock.

For complete details on all of the many Phil-trol Relays available, write for the new Catalog shown below.



Phil-trol
IS THE REGISTERED TRADEMARK OF
PHILLIPS CONTROL CORP.
JOLIET, ILLINOIS
A THOR CORPORATION SUBSIDIARY
OFFICES IN ALL PRINCIPAL CITIES

PHILLIPS CONTROL CORP., Dept. E, Joliet, Ill.
Please send me a free copy of the new Phil-trol Relay and Actuator Catalog. Also, please arrange to have a Phil-trol Sales Engineer call on me.

Name__________
Company__________
Street__________
City__________ Zone____ State______

A REAL SPACE SAVER!

the new, highly efficient...

ADVANCE TQ
MINIATURE RELAY

Only .94 cubic inches in size... only 1.2 ounces in weight—yet this new ADVANCE TQ telephone type carries 3-amp. loads in the 4PDT combination. It's available up to 6PDT, and with class "H" insulation such as Teflon, ceramic and silicone.

It's extra efficient, too, having only one air gap in the magnetic assembly. No hinge pin to wear out—there's a beryllium copper retaining spring which holds the armature rigidly in place in 3 major axes. With this construction, plus the use of cross-bar contacts, all alignment problems are eliminated.

Insulation is inorganic, and the coil requires no impregnation or filler. Hence there is no gassing or bubbling to cause contact contamination. The TQ relay is mechanically secured throughout—a feature that adds materially to its high efficiency.

EXCELLENT PERFORMANCE

The unit operates on 90 milliwatts or less, and hence can be classed as a sensitive type. Withstands 10G vibration (10 to 55 CPS). Ambient temperature ranges: −55°C to +85°C with standard coil... with Teflon coil, −55°C to +125°C. Life expectancy: 1,000,000 cycles with cross-bar contacts. Available in open and hermetically sealed types. Write for full description of the ADVANCE TQ.

ADVANCE RELAYS

ADVANCE ELECTRIC AND RELAY CO.
2435-F NORTH NAOMI STREET, BURBANK, CALIFORNIA

Sales Representatives in Principal Cities of U. S. and Canada

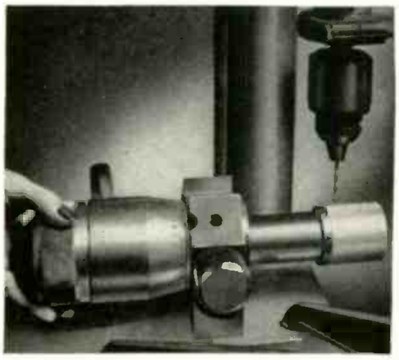
glass boards that hang vertically from ceilings.

In a 5,000-square-foot area, 320 baffles were installed by the Industrial Acoustics Company, Inc., New York, N. Y.

The baffles, manufactured by Owens-Corning Fiberglas Corp., Toledo, Ohio, are 24 by 48 inches in area and one inch thick. They are designed primarily to be hung in factory areas where overhead obstructions prevent the installation of a conventional accoustical ceiling. The baffles are covered with a thin plastic film which transmits sound waves by diaphragmatic action into the tiny, dead air pockets between the fibers of glass. They are noncombustible, washable, moisture-resistant, light in weight and may be painted without lowering the sound-absorbing efficiency.

Drilling Holes for Taps in Precision Potentiometers

A SPECIAL TOOL developed by Helipot Corp., South Pasadena, California, is used in the standard manufacturing process to drill holes for taps in the housings of multiturn precision potentiometers. The housing is mounted in a predetermined position on the armature of the giant vernier fixture. It is then possible, by rotating the barrel of the vernier, to attain great accuracy in drilling tap holes according to specification, as the equipment provides a direct reading of the helical turn in which the hole will be drilled, as well as the angular degrees on the particular turn.


Setup for precision drilling of holes in cylindrical plastic housing of precision potentiometer for computers

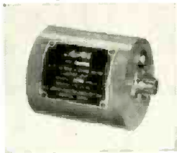
NEW

MicroMatch

MEASURES RF POWER AND VSWR IN FREQUENCY RANGE OF 0.5 TO 225 MCS. 0 TO 1 KW.

Compact, sensitive and accurate, the MicroMatch 260 Series monitors both incident and reflected power without the necessity of removing the coupler or reversing its connections. Three models are available to meet requirements of transmitter manufacturers and radio amateurs.

MODEL 261 Coupler ONLY, provides VSWR and relative power measurement when used with #261 coupler $14.50



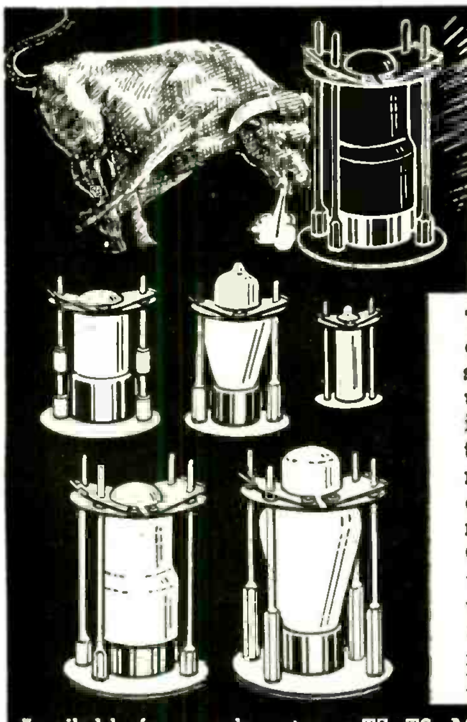
MODEL 262 Indicator ONLY, provides VSWR and relative power measurements when used with #261 coupler. $14.50

MODEL 263 Laboratory type complete coupler and indicator. Coupler equipped with N connectors. Indicator provided with 3 scales calibrated in watts, 0 - 10, 100, 1000. $85.00

M.C. Jones **M. C. JONES ELECTRONICS CO. Inc.**

BRISTOL, CONNECTICUT

Distributed outside of U.S.A. by RCA International Div., N. Y., N. Y., U.S.A.



SHOCK PROOF

VACUUM TUBE RETAINERS

These retainers are used to secure Vacuum Tubes and to resist side motion of Vacuum Tubes used in radio equipment which is subject to shock and vibrations. These retainers meet the requirement of all JAN specifications. The insulated portion is made of a melamine base Fibre Glass Phenol which provides 300 volts insulation to ground and withstands a temperature of 350 F. The insulated plate can readily be fastened or released by hand.

Available for envelope types T7, T8, MT8, T9, T12, ST12, T122DI, ST14, S14, ST16, T5½, T6½, MT-1C, ST19, T14, ST128CT-9.

Manufacturers of Electronic Components

JAMES IPPOLITO & CO., INC.
401 CONCORD AVENUE, BRONX 54, N. Y.

STOP RF LEAKAGE ON THE DRAWING BOARD

. . . WHEN YOU DESIGN METEX ELECTRONIC WEATHERSTRIPPING INTO YOUR EQUIPMENT YOU GET ITS POSITIVE SHIELDING EFFECTIVENESS — AT MAXIMUM OVERALL ECONOMY

Plan *now* to take full advantage of *Metex Electronic Weatherstripping's* unusual effectiveness in shielding all types of electronic equipment. Because it is made of *knitted* wire mesh, *Metex Electronic Weatherstripping* is both conductive and resilient. It assures positive metal-to-metal contact between all mating surfaces. And being resilient it accommodates itself positively to surface inequalities.

In reality, *Metex Electronic Weatherstripping* can do more for you than just shield RF leakage. It can cut the cost of machining mating surfaces to close tolerances. It can eliminate the need for extra fasteners and many other costly means of making joints RF tight.

Applications in which *Metex Electronic Weatherstripping* has already proved its effectiveness include pulse modulator shields, wave-guide choke-flange gaskets, local oscillators on TV sets, dielectric heaters, etc.

◀ For detailed information on METEX ELECTRONIC PRODUCTS, write for FREE copy of "Metex Electronic Weatherstrips" or outline your SPECIFIC shielding problem — it will receive our immediate attention.

METAL TEXTILE CORPORATION

METEX

ROSELLE, NEW JERSEY

NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

52 New Products and 56 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

OTHER DEPARTMENTS
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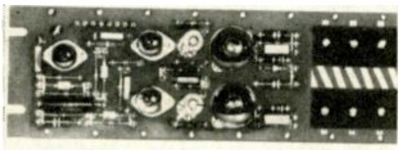
DEFLECTION YOKES
for radar systems

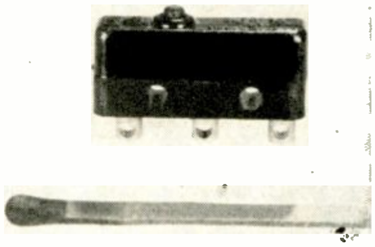
CONSTANTINE ENGINEERING LABORATORIES, Mahwah, N. J. High precision radar deflection yokes now in manufacture include rotating and stationary types for ppi and rectangular displays. High performance core materials such as mu-metal and Molly Permalloy are used. Specifications also include a wide range of inductances using complex winding distributions with h-v insulations. High efficiency, superior linearity and perpendicularity with low distributed capacitance are the outstanding features of the new deflection yokes.

SHIFT REGISTERS
operate at 125 kc



MAGNETICS RESEARCH CO., 142 King St., Chappaqua, N. Y. Four new models of magnetic shift registers have been designed for computer and other electronic system applications. They require only normal power supply voltages and a source of clock pulses in addition to the input information. Information rates of 125 kc may be handled. Each shift register contains 20 plug-in magnetic core elements (a portion of which is illustrated) arranged to store 10 bits of information. Since the output of one unit provides directly the input to another unit, these registers may be ganged serially to provide as large a binary storage system as may be required. Units may also be operated in parallel from the same timing source to provide storage for coded decimal numbers. Use is made of both printed wiring and conventional component board construction so as to insure maximum reliability, simplicity and serviceability.

TINY BASIC SWITCH
resists shock or vibration



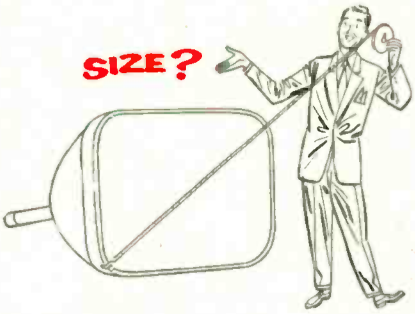
ELECTRO-SNAP SWITCH & MFG. CO., 4217-30 West Lake St., Chicago 24, Ill., has available a subminiature basic switch for use on electronic equipment, guided missiles, rocket launchers and many other military and commercial applications. A patented snap-action S-type spring compression member that equalizes the stress on the switch springs prevents early fatigue commonly caused by concentrated stress on only one part of the spring. Snap-of the speed of actuation. This switch has no dead center and is resistive to shock or vibration. Three standard actuators are available: toggle, pushbutton and leaf-spring. Switches are available normally closed spst, normally open spst or spdt.

GENERATOR
produces color test signal

RADIO CORP. OF AMERICA, Camden, N. J., has developed inexpensive equipment for use in tv stations to expedite installation and performance checks of color tv receivers in homes while black-and-white programs are on the air. Use of the

What are your
Aluminized Picture Tube
Problems?
Better Contrast!
Longer Life!
Availability!
SYLVANIA
1 YEAR WARRANTY

Now Sylvania offers a full line!

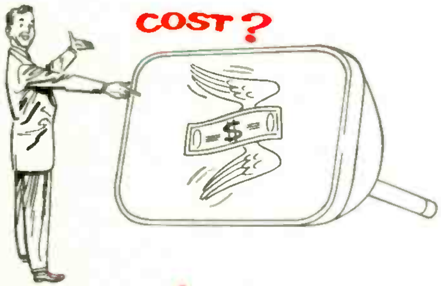


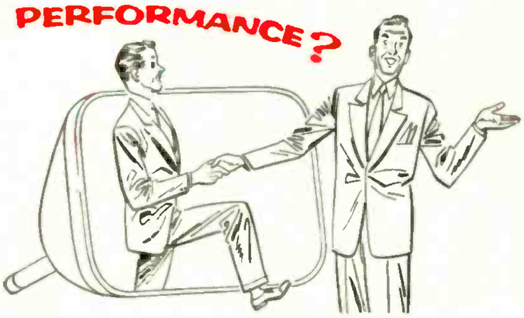
TODAY, because of greatly increased facilities and improved manufacturing techniques, Sylvania is in a position to offer you perfect answers to your aluminized picture tube problems.

And, much more than your physical spec requirements, Sylvania Aluminized Tubes also offer the finest *performance!* These tubes give whiter whites and blacker blacks . . . a 6-times better picture contrast.

This means Sylvania's new aluminized tubes make your sets stand out ahead of competition. The improvement is obvious . . . and immediate. And the low prices will amaze you!

For the full story concerning Sylvania's complete aluminized tube line, and how they can help your future sales, write a note on your letterhead to Dept. 4R-1607 at Sylvania TODAY!




PERFORMANCE?

SYLVANIA

Sylvania Electric Products Inc. 1740 Broadway, New York 19, N. Y.

In Canada: Sylvania Electric (Canada) Ltd.
University Tower Building, St. Catherine Street, Montreal, P. Q.

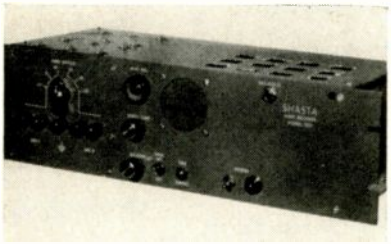
LIGHTING · RADIO · ELECTRONICS · TELEVISION

equipment by tv stations will enable service technicians to check color set reception during normal servicing hours, without waiting for color signals which may not be available on a scheduled basis at convenient times. It helps furnish a complete system check from station transmitter to home receiver. It makes possible checking such phases as the air patch from the station transmitter to the home, proper orientation of the roof-top antenna, and whether the transmission line from antenna to receiver is capable of carrying a color signal. The color test signal is a narrow vertical yellow-green bar which is visible at the extreme edge of color receivers but is practically unnoticeable on black-and-white sets.

UNIT PULSER
has varied applications

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Continuously adjustable pulse durations from 0.2 μsec to 60,000 μsec are available from the type 1217-A unit pulser. It is powered by the type 1203-A unit power supply to which it is easily attached. A self-contained oscillator drives the output at 12 fixed frequencies from 30 cycles to 100 kc, and provision is made for external triggering at any frequency below 100 kc. Pulse rise time is less than 0.05 μsec; and fall time, about 0.15 μsec. The open-circuit output voltage is 20 v for pulses of either polarity. Internal output impedance is about 200 ohms for positive pulses and 1,500 ohms for negative pulses. The 1217-A can approximate all three basic pulse-source waveforms: impulse, step function and periodically repeated pulse of adjustable duration. Typical of its many applications are: square-wave testing of audio systems; gate or time-delay generator in testing computer systems; checking overall transient response of tv video system; and laboratory experiments in transient analysis.

WWV RECEIVER
is crystal controlled



SHASTA DIVISION, Beckman Instruments Inc., P. O. Box 296, Richmond, Calif. Model 1201 WWV receiver is crystal controlled, having six bands at 2.5, 5, 10, 15, 20 and 25 mc, selectable by panel switch. The circuit features dual conversion and narrow-band i-f stages for maximum selectivity and image rejection. Four i-f stages insure adequate sensitivity for good reception under the most difficult conditions. A cathode-coupled crystal oscillator circuit is utilized having fine tuning control for the 6 plug-in crystals. The instrument is expected to find wide application in laboratories engaged in work requiring precise measurements of r-f or audio frequencies, or time signals provided by station WWV.

TAPE RECORDER
is professional and portable

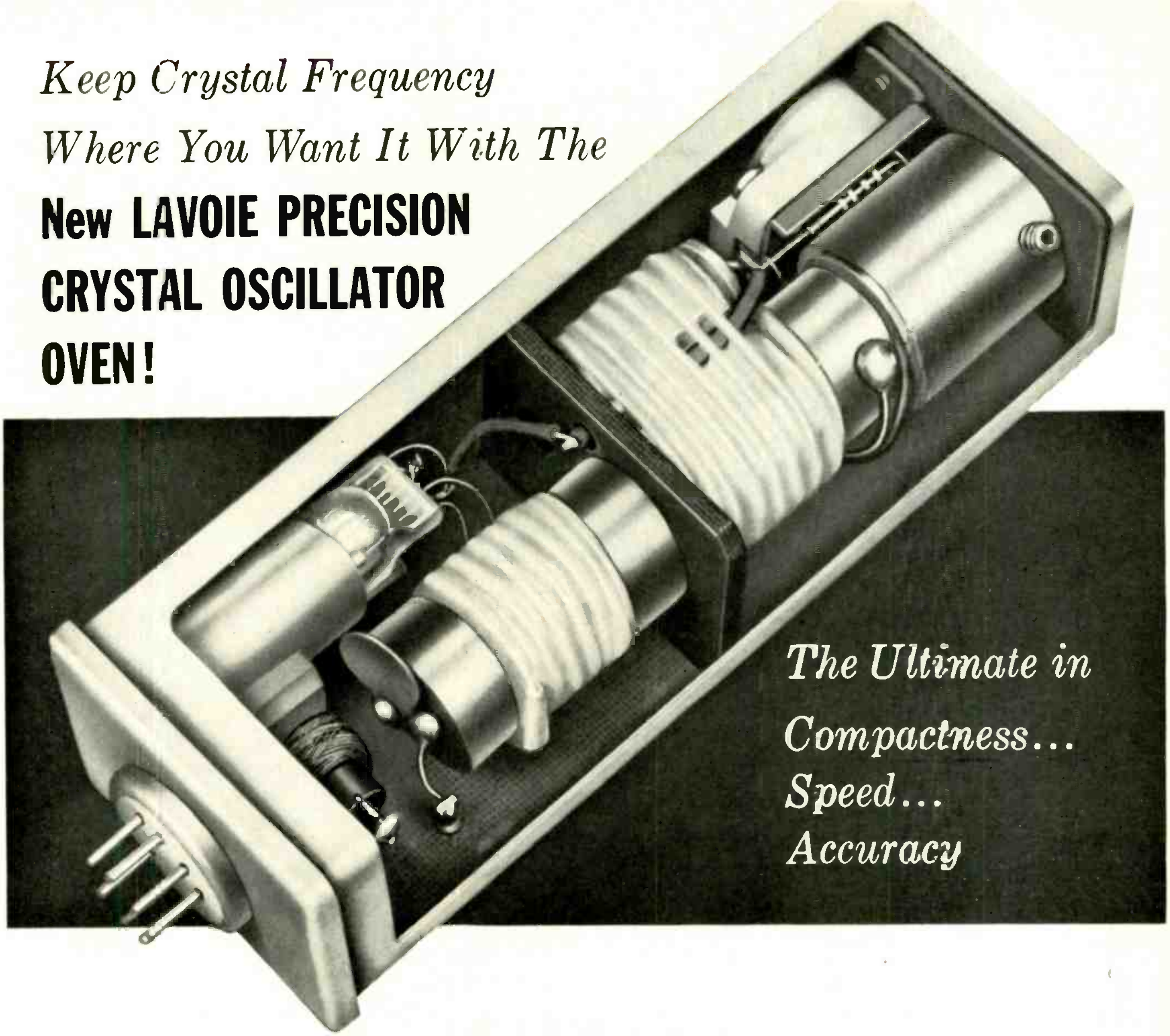
AMPEX CORP., 934 Charter St., Redwood City, Calif. Model 600 tape recorder embodies professional recording standards in a truly portable unit. It weighs only 28 lb, and measures 16 in. × 14 in. and is 8 in. thick. Frequency response is 30 to 15,000 cycles at 7½ ips; signal-to-noise ratio, over 55 db; and every machine is tested to meet or exceed specifications. Among the features of the recorder is a built-in mixer that will enable a user to record from a microphone at the same time he is recording from a radio or record changer. The new unit will find wide usage among broadcast stations, recording studios, schools and home users interested in fine musical reproduction. Price is $545.

UHF-VHF TUNER
combines two separate units

SARKES TARZIAN, INC., 539 S. Walnut, Bloomington, Ind., announces a, compact, tv tuner, the UV-13, covering the full uhf and vhf bands. It is actually two separate tuners mounted coaxially and plugged together to make a single, compact

Keep Crystal Frequency
Where You Want It With The

New LAVOIE PRECISION CRYSTAL OSCILLATOR OVEN!



The Ultimate in
Compactness...
Speed...
Accuracy

The new Lavoie Precision Crystal Oscillator oven is designed to serve as a plug-in expendable circuit element. It supplies a precise output frequency determined by the interior mounted temperature-controlled crystal. The unit is unusually compact with the vacuum tube and all circuit elements mounted inside the oven case. This design insures a degree of accuracy not normally obtained in a unit of comparable size. If you are designing and building airborne or transportable communications equipment, you will want to know more about this newest Lavoie development. Write for details.

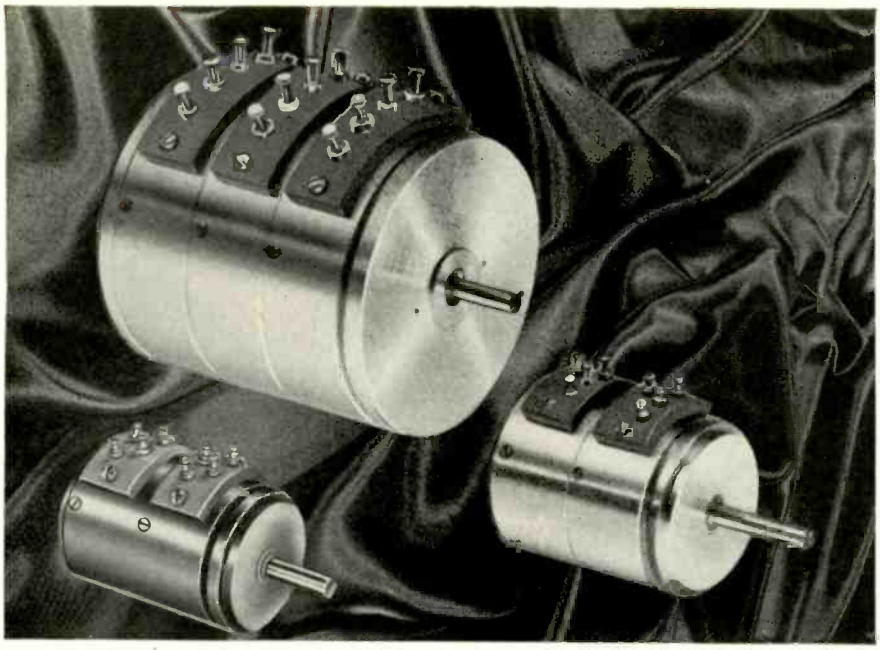
PERFORMANCE CHART

Oscillators	#1	#2	#3	#4	#5
Frequency deviation when first turned on at room temp.	110 cycles	90 cycles	140 cycles	100 cycles	120 cycles
Warm-up time to 50 cycles deviation from room temp.	45 seconds	70 seconds	75 seconds	60 seconds	60 seconds
Frequency deviation at room temp. after warm-up	2.3 cycles	0.07 cycles	3.10 cycles	3.3 cycles	2.8 cycles
Frequency change at room temp. when output is loaded with 10 mmf capacitor	-2.5 cycles	-1.0 cycles	-0.5 cycles	-0.6 cycles	-0.8 cycles
Frequency change at - 55°C ambient	0.02 cycles	0.5 cycles	0.9 cycles	0.35 cycles	0.03 cycles
Frequency deviation when first turned on at - 55°C ambient	[illegible] cycles	300 cycles	300 cycles	480 cycles	510 cycles
Warm-up time to 50 cycles deviation from - 55°C ambient	4 minutes	4 minutes	4½ minutes	4½ minutes	5 minutes

SPECIFICATIONS:

Frequency 500 kilocycles
Max. Deviation after 15 min. warm-up ±0.0012% (6 cycles at 500 kc)
Operating Temp. —55 to +80°C
Pressure 3 to 30 inches mercury
Vibration 10 to 55 cps (0.015 inches amplitude)
Shock 10 G
Humidity 30 days cycling at 100% RH at 50° C
Orientation Any position
Warmup ±0.01% (50 cps) after 3 minutes under any condition; after 1 minute at room temp.
Weight 9 ounces maximum
Connections Miniature 7 pin base
Supply voltages Heater: 6-12-28-110 volts, 30 watts Filament: 6.3 volts Plate: 75 volts, 3 ma max.
Load 100,000 ohm grid circuit, variation of 10 mmf shall not produce frequency change in excess of allowable stability.
Life Not less than 500 hours without servicing; 2000 hours with reasonable servicing.

Lavoie Laboratories, Inc.
MORGANVILLE, NEW JERSEY



Three NEW
Fairchild Precision Potentiometers

TYPE 751 7/8"
TYPE 741 1⅛"
TYPE 754 2"
LINEAR

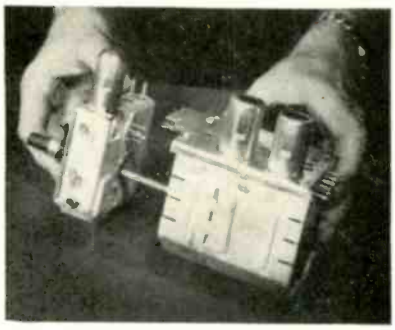
Type 751, resistance range 400 to 20,000 ohms, linearity ±0.5% or better; Type 741, resistance range 500 to 25,000 ohms, linearity ±0.5% or better; Type 754, resistance range 800 to 100,000 ohms, linearity ±0.15% or better. All are extremely compact and are available with servo mounts. Internal clamp rings permit ganging without increasing overall diameter. All have gold-plated terminals for reduced contact resistance and easier soldering. Standard resistance values Types 741 and 751—500, 1000, 5000, 10,000, 20,000 ohms; Type 754—1000, 5000, 10,000, 20,000, 50,000 ohms.

Three more reasons why Fairchild can supply ALL your precision potentiometer needs

Fairchild makes a complete line of precision potentiometers to fill all your needs—linear and nonlinear potentiometers, single or in ganged combinations . . . single-turn, helical and linear motion . . . with servo or threaded bushing mounts . . . and with resistance elements to meet your requirements.

Fairchild guarantees accuracy of ±1% in nonlinear types and ±0.5% in linear types. Highly accurate production methods and close mechanical tolerances, plus thorough type-testing and quality control, assure high resolution, long life, low torque and low electrical noise level in every Fairchild potentiometer. For more information, or for help in meeting your potentiometer problems, call on Fairchild Camera & Instrument Corp., Potentiometer Division, 225 Park Avenue, Hicksville, L. I., N. Y., Department 140-53A1.

FAIRCHILD
PRECISION POTENTIOMETERS



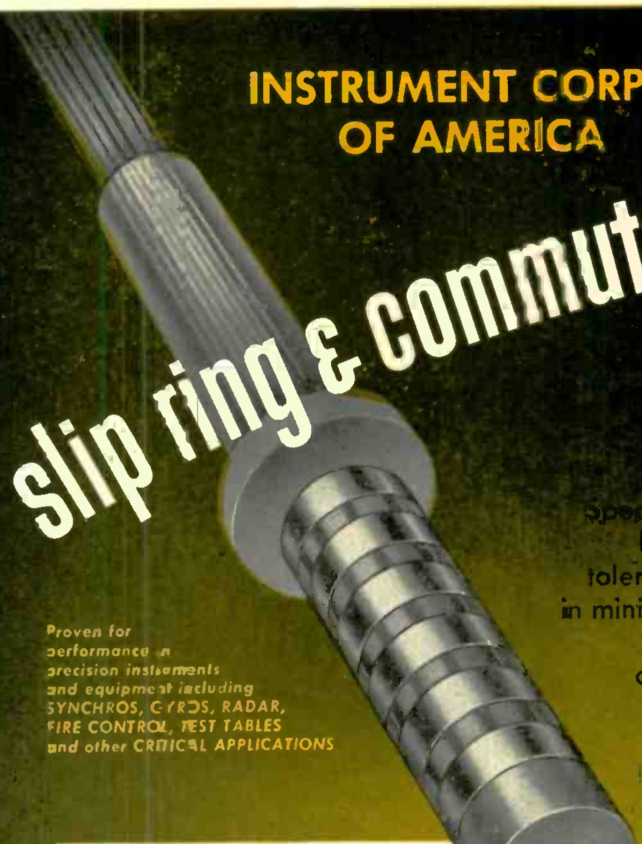
unit no larger than the standard vhf tuner. Logical straight line electrical sequence of compartmented circuits is the basic design feature. This eliminates regeneration, pickup of spurious signals and other undesired effects due to stray capacitances and inductances. The two units combined measure 3$\frac{5}{16}$ in. wide × 3$\frac{17}{64}$ in. high × 4$\frac{3}{4}$ in. deep. Tube height above the chassis may be kept to 1$\frac{7}{16}$ in. The complete tuner consists of a cascode vhf tuner and a capacitance-tuned, resonant coaxial cavity, uhf tuner. Installation consists of slipping one over the shaft of the other, tightening two screws and attaching the proper knobs. Other features include 41-mc single superhet conversion and many circuit stabilizing features such as Invar temperature compensation and gain stabilization. The tuner is suited for use as original equipment in both color and monochrome sets and as a replacement unit for older sets.

POWER SUPPLY
is frequency stabilized

MARYLAND ELECTRONIC MFG. CORP., College Park, Md., announces production of the model ME/PP-11, a 200-w frequency stabilized power supply. It is designed to provide a stable 60-cps 115 or 230-v source to

INSTRUMENT CORPORATION OF AMERICA

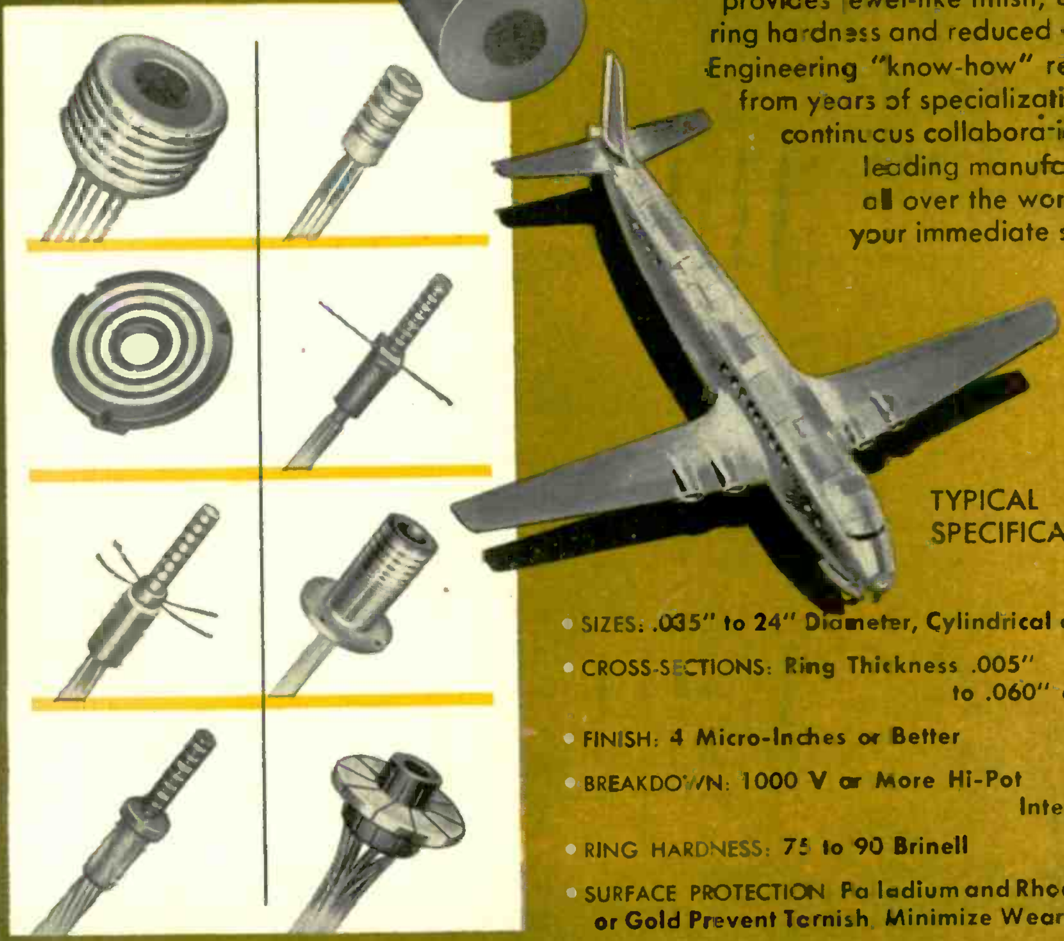
slip ring & commutator assemblies



One-piece construction* assures high accuracy and super-dependability to the most rigid specifications.

Proven for performance in precision instruments and equipment including SYNCHROS, GYROS, RADAR, FIRE CONTROL, TEST TABLES and other CRITICAL APPLICATIONS

Specify Instrument Corporation of America Slip Ring and Commutator Assemblies for closer tolerances, absolute uniformity and the ultimate in miniaturization. Wherever extreme dimensional precision, accurate concentricity and high dielectric qualities, are required, Instrument Corporation of America assemblies are specified with confidence. One-piece, unitized construction eliminates dimensional variation due to accumulated errors, provides jewel-like finish, uniform ring hardness and reduced weight. Engineering "know-how" resulting from years of specialization and continuous collaboration with leading manufacturers all over the world is at your immediate service.



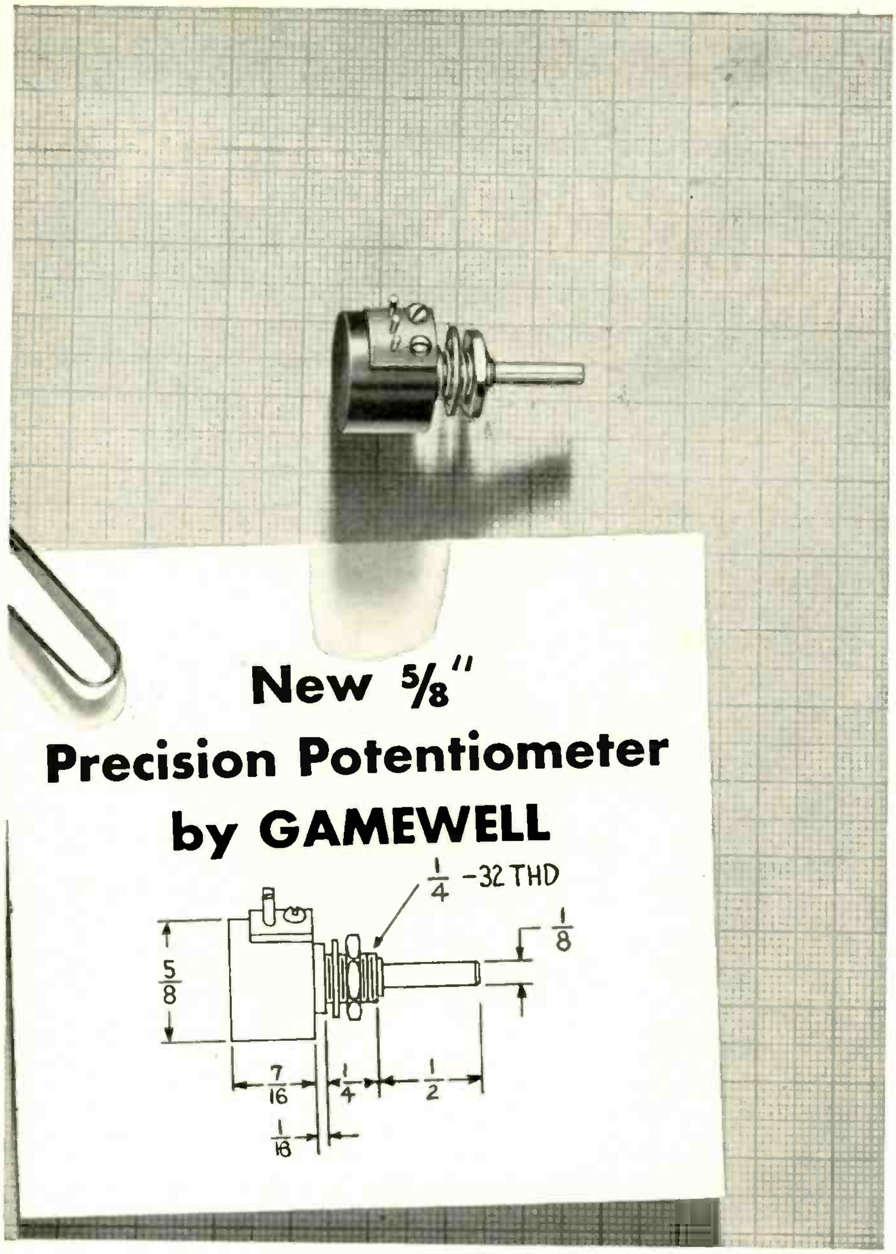
TYPICAL SPECIFICATIONS

- SIZES: .035" to 24" Diameter, Cylindrical or Flat
- CROSS-SECTIONS: Ring Thickness .005" to .060" or More
- FINISH: 4 Micro-Inches or Better
- BREAKDOWN: 1000 V or More Hi-Pot Inter-Circuit
- RING HARDNESS: 75 to 90 Brinell
- SURFACE PROTECTION: Palladium and Rhodium, or Gold Prevent Tarnish, Minimize Wear & Noise

INSTRUMENT CORPORATION OF AMERICA

BLACKSBURG · VIRGINIA

*ELECTRO DEPOSITION PROCESS AVAILABLE UNDER EXCLUSIVE LICENSE AGREEMENT WITH ELECTRO TEC CORP.



New 5/8" Precision Potentiometer by GAMEWELL

Here is a 5/8" potentiometer that offers you the extreme precision found in larger sizes of Gamewell Potentiometers.

Body is of anodized aluminum and the shaft is made of stainless steel. Kohlrausch type winding provides excellent linearity and the unit meets MIL-E 5400 specifications as they apply.

The unit can be modified for special mounting. Write for additional information about this miniature precision potentiometer.

CONDENSED TECHNICAL DATA:

Resistance	*30K ±5%
Min. Resistance	25 ohms
Linearity	*0.25
Electrical Angle	345°
Resolution	*0.1% (1000T)
Test Voltage	900 RMS
Temperature	105°C
Watts	1
Size	5/8" OD 7/16" long
Torque	0.2 oz.-in.

*Maximum Values

THE GAMEWELL COMPANY
NEWTON UPPER FALLS 64, MASS.

GAMEWELL®
PRECISION POTENTIOMETERS
Manufacturers of Precision Electrical Equipment Since 1855

operate frequency-critical devices requiring up to 200 w in areas where the line frequency is not dependable. It consists of three units —a h-v power supply, a 60-cps generator and a 60-cps amplifier. Input frequency range is from 50 to 70 cps; input voltage, 115 v; input power, 850 w. Output frequency may be accurately adjusted anywhere in the range of 55 to 65 cps at either 115 or 230 v. Output impedance is 265 ohms across 230-v output taps, 66 ohms across 115-v output taps. The equipment (three chassis) is contained in a $42\frac{1}{16}$ in. high cabinet.

DC-AC CHOPPER
STEVENS-ARNOLD INC.
SOUTH BOSTON, MASS.

D-C/A-C CHOPPERS
in twenty-two models

STEVENS-ARNOLD, INC., 22 Elkins St., Boston, Mass., announces a completely redesigned line of 60-cycle d-c/a-c choppers for low-level operation at noise levels under 1 μv. Twenty-two models are now available for use as modulators, demodulators or square-wave generators. They are offered for both single-pole and double-pole application in computers, business machines, recording potentiometers, servomechanisms, regulated power supplies and microvolt meters.

D-C AMPLIFIER
features magnetic converter

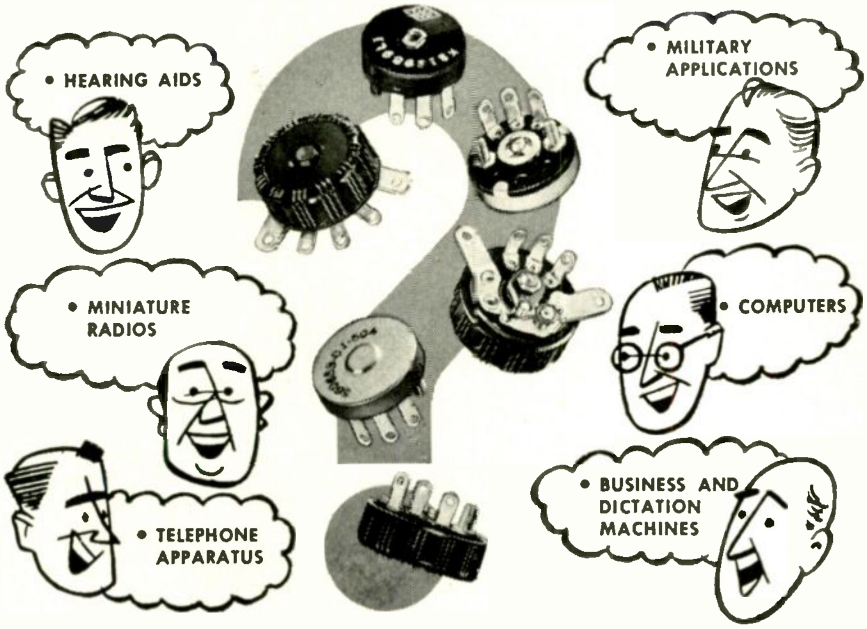
DOELCAM CORP., 1400 Soldiers Field Road, Boston 35, Mass., has released a commercial-type percision instrument that can measure signals as low as 2×10^{-15} w. The 2HLA-3 d-c indicating amplifier incorporates the new principle of the second-

harmonic magnetic converter in the input stage of the instrument. This converter (first of four stages) overcomes limitations such as wear, fatigue, stickiness and other inherent difficulties that often cause failures, sporadic disturbances and shorter life. The second-harmonic magnetic converter replaces the mechanical converter and eliminates all moving parts. In the second stage a very high gain voltage amplifier magnifies the a-c signal received from the converter. The demodulator in the third stage then changes the amplified a-c signal to d-c. At the fourth stage a power amplifier greatly increases the power output to the meter on the face of the instrument or to the output terminals where sufficient power is supplied to drive an inking recorder or a control device. A self-contained power supply furnishes energy to the voltage amplifier, power amplifier and oscillator.

VHF RECEIVER
covers 50 to 200-mc range

SERVO CORP. OF AMERICA, New Hyde Park, N. Y. Model SS50-200 vhf receiver, for a-m and f-m in the 50 to 200-mc range, is ideal for general communication, laboratories,

Just how many uses are there for Centralab Model 1 Radiohms®?



Industry's top choice miniature variable resistor is available in plain, high-torque and switch types

Frankly, we don't know just how many miniaturization problems the Model 1 is solving. Enthusiastic reports of new cost-saving applications arrive daily!

Smaller than a dime, the Model 1 gives you dollars of value in smooth performance, light weight and long life. Use it wherever space is at a premium and high-quality characteristics are required.

More proof that the Model 1 is designed for today's needs:

- RESISTANCE — 500 ohms to 10 megohms. Seven tapers. 1/10 watt rating.
- KNOB OR SCREWDRIVER ADJUSTMENT.
- STANDARD TORQUE — 0.3 ounce-inches.
- HIGH TORQUE — 3.0 ounce-inches.
- PLAIN OR SWITCH TYPES — dust proof.
- 25,000 CYCLE LIFE MINIMUM.

Dictate a letter TODAY for Bulletin 42-164!

Standard items available at your local (CRL) distributor, see catalog 29

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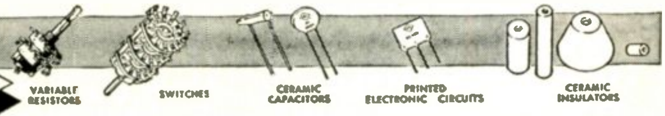
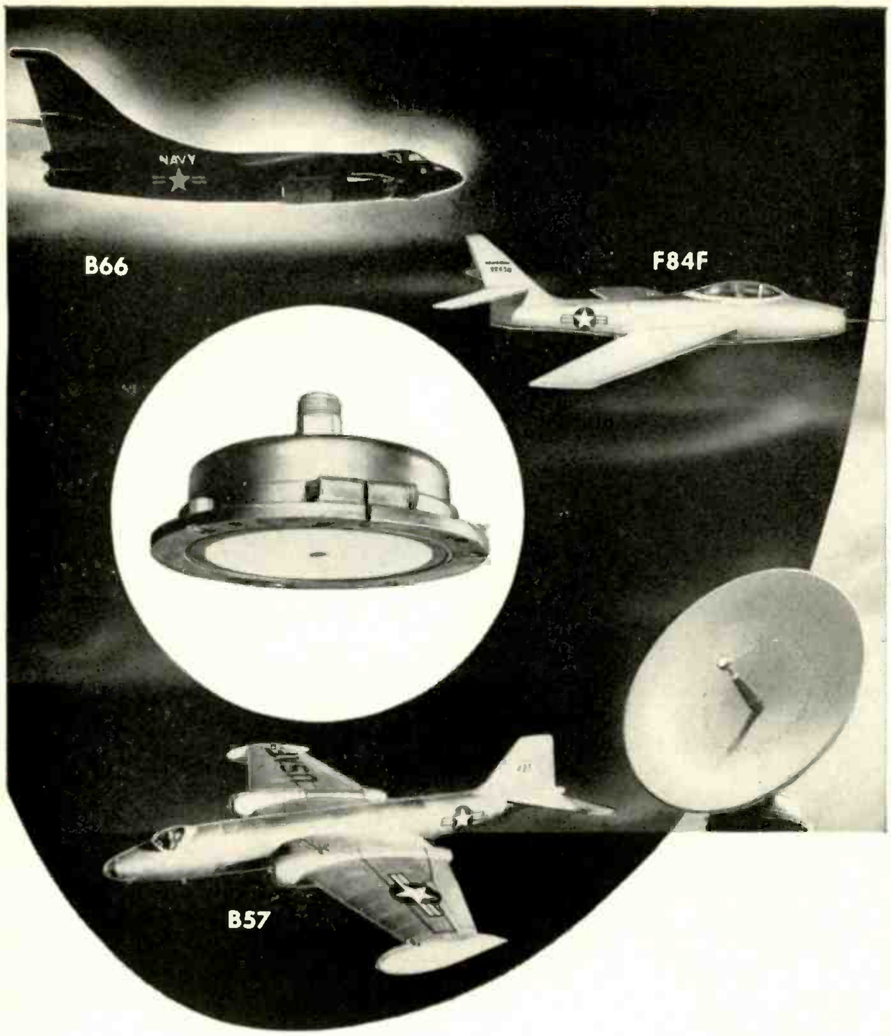


Industry's greatest source of standard and special electronic components

B-6



ANTENNA PRODUCTION

ADVANCED—*from the ground up*

At whatever point Gabriel takes over your antenna problem — prototype, blueprint, or just basic idea — the result is improved performance.

When Gabriel product-engineered the pressurized radome of the flush-mounted aircraft antenna shown, a major obstacle to large scale production was cleared. Result — Gabriel mass production for F84F, B57, B66 and other aircraft with improved dependability, uniformity, and economy.

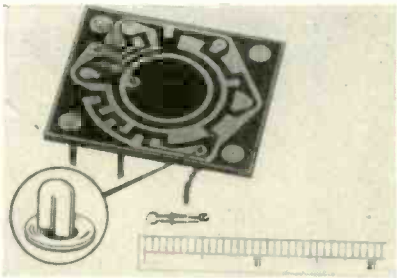
To improve MTI radar, Gabriel started from the ground up . . . developed for production the SCR 584 shown, a 10-foot parabolic antenna with circularly-polarized conical scanning feed, crossover level at −3 db.

These are typical Gabriel solutions to government and industry's problems of airborne, shipborne, and ground-based antennas. The Electronics Division's engineering and production facilities are supplemented by the specialized research facilities of the famous Gabriel Laboratories.

For a thorough description of these integrated facilities for antenna research, development, and production, write for our new 24-page "Facilities Report". Or ask for a Gabriel antenna specialist to call.

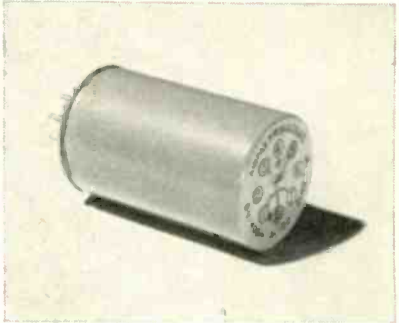
GABRIEL ELECTRONICS DIVISION
Formerly Workshop Associates Division
THE GABRIEL COMPANY, 230 Endicott Street, Norwood, Mass.

f-m monitoring, direction finding, teletype and telemetering. Bandwidth is variable from 25 kc to 150 kc, power input 125 w from 115/230 v, 50/60 cycle. It features an easy reading directly-calibrated 72-in. bandspread dial.



TINY CONNECTOR
is automatic locking

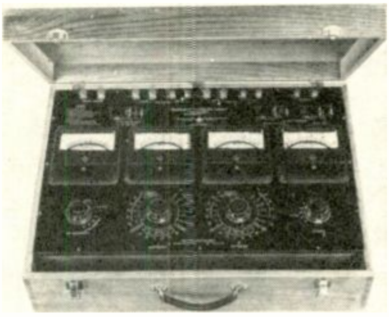
HARVEY HUBBELL, INC., Bridgeport, Conn. This subminiature connector has all the features of the Interlock line—automatic locking, quick disconnect action, vibration-proof lock and low contact resistance. Its size (slightly over ½ in. in length) makes it ideally adaptable for printed circuit use. Illustration shows its application to a rotary switch plate circuit, manufactured by Photocircuits, Inc., of Glen Cove, N. Y. Note how the wired plugs enter through set-in eyelets and lock automatically (inset shows contact magnified). Plug can easily be disconnected, yet never disconnects accidentally.



CHOPPER
is hermetically sealed

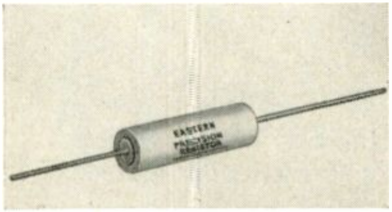
AIRPAX PRODUCTS CO., Middle River, Baltimore 20, Md., announces the model A-100, a chopper capable of continuous operation in an ambient temperature as high as 200 C. Hermetic sealing is obtained by the use of silver-lead solders and class

C materials are used internally. The chopper will also operate successfully at −70 C, for a total operating range of 270 C. The unit is a 400-cycle, 6.3-v break-before-make chopper, having a nominal phase angle of 65 deg and a dwell time of 135 deg. Complete specifications will be sent upon request.



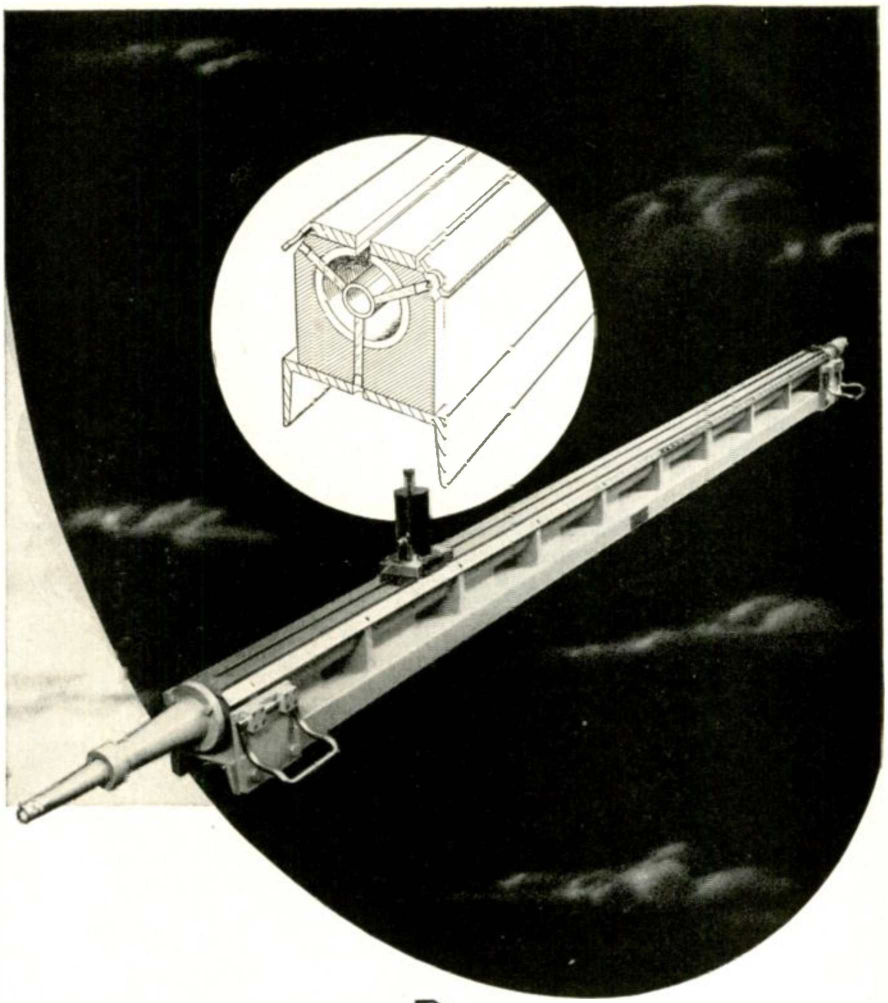
A-C TEST SET
is compact, rugged, accurate

SENSITIVE RESEARCH INSTRUMENT CORP., 9–11 Elm Ave., Mt. Vernon, N. Y. Engineers in research and development laboratories can use the Universal 60 a-c test set for measuring equipment capable of giving the complete picture of 60-cycle voltages, currents, power and power factor. The unit features a compact, rugged and accurate set of instruments that are designed to be used together. There are 4 separate instruments in the set with their necessary switches which create: 36 ranges in watts, 7 current ranges and 4 ranges in volts. All the instrument ranges are completely switch controlled. A four-page bulletin contains illustrations and full description.



RESISTORS
for high-temperature use

EASTERN PRECISION RESISTOR CORP., 130-11 90th Ave., Richmond Hill, L. I., N. Y., has announced the Hi-Temperatures, a new line of re-



versatile
high precision } **SLOTTED LINES**

To meet the ever-expanding need for accurate impedance and VSWR measurements, Gabriel Laboratories has designed several high-precision coaxial slotted lines. For VHF, models are available for frequencies ranging down to 50 mc. These lines can be supplied with a characteristic impedance of 51.1 or 50 ohms. Unique design of the center conductor supports, permits accurate, adjustable centering of the line. Residual VSWR is less than 1.02.

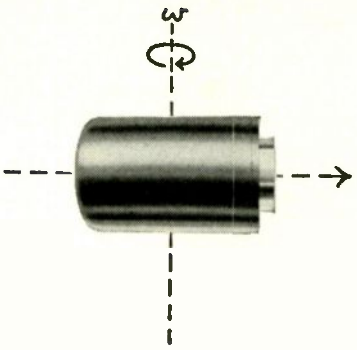
Two probe types are available: (1) RF output for use with receiver, and (2) tuned probe with self-contained bolometer or crystal. The lines are supplied with precision tapers for measurement in systems employing either standard 7/8-inch flanges or type N connectors. Tapers for RTMA 3 1/8-inch lines, 1 5/8-inch lines and RG17/U cable connectors can be supplied. Standard models are 6-foot allowing for measurements down to 100 mc., and 10-foot for measurements down to 50 mc. Both models are efficient, rugged and come equipped with handles for ease in handling.

For precision UHF impedance measurement in systems employing RTMA standard transmission lines, a special slotted line is available. It connects directly to RTMA standard flanges, 3 1/8-inch or 1 5/8-inch. Residual VSWR is less than 1.02. Standard lengths are 18 inches and 25 inches to suit the use of UHF TV measurements. The lines are supplied with either RF or tuned bolometer probes. A single adaptor to a type N connector simplifies connecting the signal generator.

For further information write Gabriel Laboratories, 135 Crescent Street, Needham Heights, Massachusetts, or phone NEedham 3-0005.

THE GABRIEL LABORATORIES
THE GABRIEL COMPANY, 135 Crescent Street, Needham Heights, Mass.

Kearfott developed RATE GYROS in production



Eight basic rate gyros developed and produced by Kearfott are available for rate measurement, rate integrating or rate cutout applications.

SPRING RESTRAINED RATE GYROS

Max. Measuring Rate 12°/sec. to 720°/sec.

Type	Max. Output Null Ratio	Ratio Max. to Min. Input Rate	Dimensions	Weight
STANDARD	300:1	1000:1	2 3/8" x 3 7/8"	2 lbs.
HIGH SENSITIVITY	1000:1	2000:1	2 5/16" x 4 1/4"	4 1/2 lbs.
MINIATURE	1000:1	1500:1	2" x 3 5/16"	1 lb.

FLOATED RATE INTEGRATING GYROS

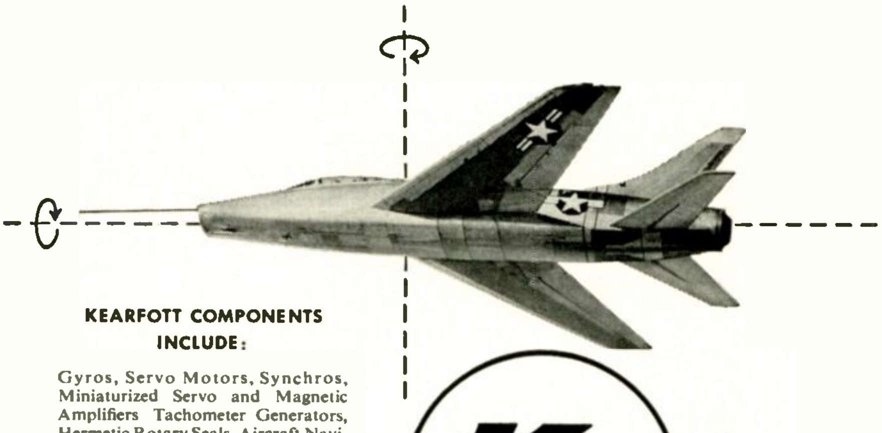
Type	Damping Ratio	Dimension	Weight	Drift Standard Deviation
HIGH ACCURACY	.3	6" x 3 3/4"	6.4 lbs.	.1°/hr.
MINIATURE	1	2" x 3 21/32"	1 3/8 lbs.	1/3 millirad/sec.

GYRO ACTIVATED RATE SWITCHES

Type	Cutout Rate	Dimensions	Weight
STANDARD	25°/sec.	3 1/2" x 5 3/32"	3 3/4 lbs.
MINIATURE	25°/sec.	3 1/2" x 4 3/16"	2 3/4 lbs.
SUBMINIATURE	15°/sec.	2" x 3 5/16"	3/4 lbs.

Kearfott Gyros are hermetically sealed in a dry inert gas and feature high pickoff output thus eliminating bulky external amplifiers.

Additional data and prices will be sent on request



KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Synchros, Miniaturized Servo and Magnetic Amplifiers Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

Visit the Kearfott display at the Western Electronic Show and Convention, August 25-27 at the Pan-Pacific Auditorium, Los Angeles, California.

Kearfott
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Sales and Engineering Offices: 1378 Main Avenue, Clifton, N. J.
Midwest Office: 188 W. Randolph Street, Chicago, Ill. South Central Office: 6115 Denton Drive, Dallas, Texas
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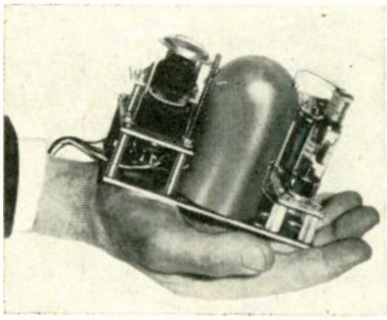
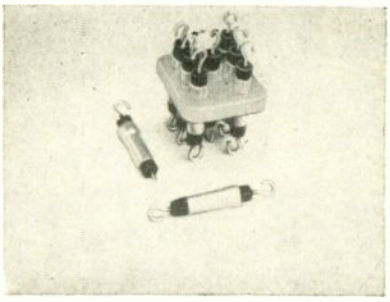
sistors designed to withstand continuous heat up to 100 C. They are completely encased in ceramic with axial lead mounting for easy connecting. Resistance and tolerance markings can be stamped on the ceramic for added convenience. Surpassing all military specifications, the new precision wire-wound resistors are available with glass, silicone or Teflon covered wire.



H-V POWER SUPPLY
is an all-purpose unit

SERVO CORP. OF AMERICA, New Hyde Park, N. Y. Model PS503 is an efficient h-v power supply weighing only 2 lb and measuring 4 in. × 2⅝ in. × 5½ in. Input of 275 v d-c provides 5,000 v d-c at 300 μa. Lower voltage at higher current can be obtained if desired. The transformer is hermetically sealed in epoxy resin casting and operates on 30 kc. The unit is an ideal all-purpose power supply for applications where size and weight must be kept at a minimum.



RUBBER TERMINALS
are hermetically sealed

ROBCO MFG. DIVISION, Pilot International Corp., 27-01 Bridge Plaza North, Long Island City, N. Y., has available new hermetic-seal feedthrough rubber terminals. Formed of rubber insulated, copper-clad steel wire, excellent sealing proper-

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You'll be well repaid by getting the facts on a special group of Pure Ferric Oxides, developed by Williams especially for use in the manufacture of ferrites.

Williams Ferric Oxides analyze better than 99% Fe_2O_3. They contain a minimum of impurities. They are available in a broad range of particle sizes and shapes. Among them, we're certain you'll find one that's "just right" for your requirements. The proper application of Ferric Oxides to the manufacture of Ferrites is our specialty.

Tell us your requirements . . . we'll gladly send samples for test. Chances are good that our Ferric Oxide "Know How" can save you considerable time and money. Address Dept. 25, C. K. Williams & Co., Easton, Pa.

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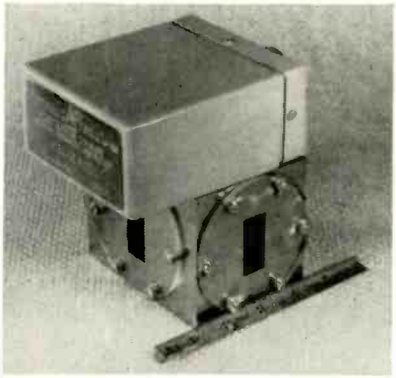
P.S. We also procuce IRN Magnetic iron powders for the Electronic Core industry, the Magnetic Tape Recording industry and others. Write for complete technical information.

ties are achieved by crimping a tinned copper sleeve over the rubber insulation which is chemically bonded to the wire. These terminals provide high leakage resistance, high dielectric strength and prevent metallic migration under d-c potentials. Oil leakage is prevented even under internal pressures of 30 psi. The rubber insulation also absorbs shock and vibration, affording long service life. These terminals may be mounted on 3/16-in. centers with a minimum over all length of 1 5/64 in.

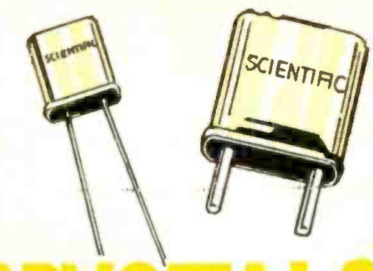


WAVEGUIDE SWITCH
is a compact unit

THOMPSON PRODUCTS, INC., Electronics Division, 2196 Clarkwood Road, Cleveland 3, Ohio, has available the model ASWI-X01 waveguide switch with a 3/4 in. by 1 1/2 in. guide size. It has the following features: vswr—1.05 to 1 maximum; crosstalk—50 db minimum; actuator—110 v, 60 cycle; actuation time—0.5 sec maximum; vswr during switching—1.2 to 1; and power handling ability — approximately 0.35 megawatt c-w.

SPECTRUM ANALYZER
covers 10 to 22,000 mc

POLARAD ELECTRONICS CORP., 100 Metropolitan Ave., Brooklyn 11, N. Y., has available model TSA portable all-band spectrum analyzer, covering the range of 10 to 22,000 mc with three interchangeable r-f heads. A single dial, direct-reading, r-f tuning control allows for quick and simple selection of any frequency spectrum. A swept i-f yields constant dispersion characteristics



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will design and build
GASOLINE ENGINE DRIVEN
GENERATORS
to meet your toughest specifications

A TYPICAL
HOMELITE EXAMPLE

This Homelite Gasoline Engine Driven Generator made to operate sensitive electronic equipment requiring close voltage regulation with or without a floating battery was designed to meet MIL-G-10286A. Some of its requirements are as follows:

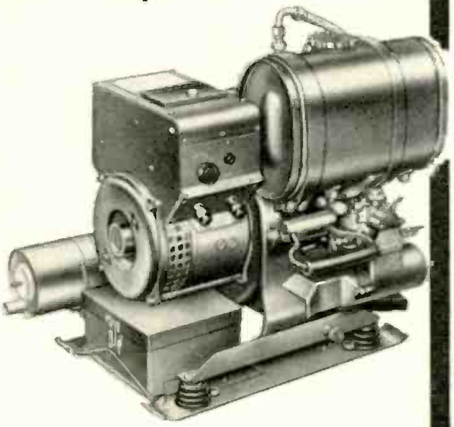
Military Rating — 0.5 KW 28 V D.C. at 5000 Ft. Altitude

Dry Weight — approx. 80 lb.

Dimensions — 20" x 17" x 18½".

Voltage Regulation — 4%.

Radio Suppression — MIL-S-11683.



Climate — −65°F to 125°F.

No matter what your requirements are for gasoline engine driven generators, it will pay you to contact Homelite. For more than thirty years Homelite has specialized in such generators and the Homelite reputation for *successfully* meeting military specifications with dependable lightweight units is one that's clearly written on the records. Write and our engineering and manufacturing facilities will be at your service.

Homelite builds generators in sizes from .15KW up to 5KW in all voltages and frequencies . . . with either gasoline engine or electric motor drive.

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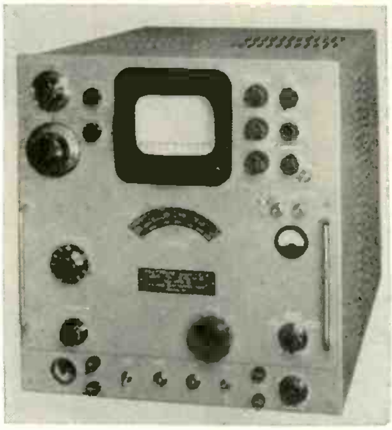
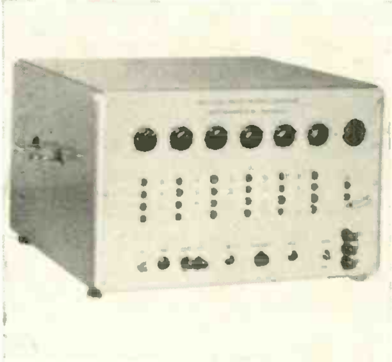
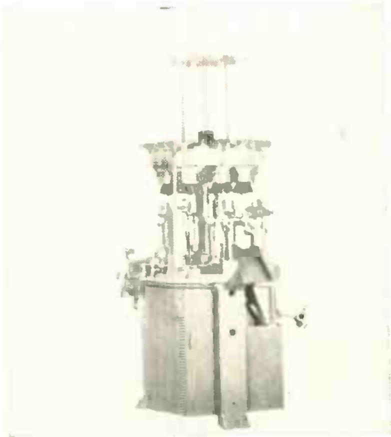


completely independent of frequency setting. Frequency dispersion from 250 kc to 25 mc may be realized with a resolution of 25 kc. An internal marker is provided to measure frequency differences up to ±12.5 mc on a 5-in. crt display, the difference figure being read directly off a calibrated control. Sensitivity is better than −80 dbm over the entire range with a built-in r-f attenuator in the tuning unit to accommodate large signals.



INTERVAL GENERATOR
is mc predetermined counter

POTTER INSTRUMENT CO., INC., 115 Cutter Mill Road, Great Neck, N. Y. Model 564 preset interval generator is designed for testing and calibrating systems that rely on precise time measurements for their operation. Radar, sonar and certain types of telemetering equipment are typical examples. Time intervals and delays from 1 μsec to 1 sec may be generated or measured. In essence, the 564 is a megacycle predetermined counter with a built-in time-base oscillator that uses a temperature-controlled 1-mc crystal for long-term frequency stability. Indication is by means of neon lamps arranged to give 6-digit readings directly in microseconds. Intervals of the order of seconds are generated with better than 0.0001-percent accuracy. Manual or automatic reset may be used. A separate amplifier and shaper unit is provided for applications where an external time base source is used for simulating target delays selectable directly in feet or yards.

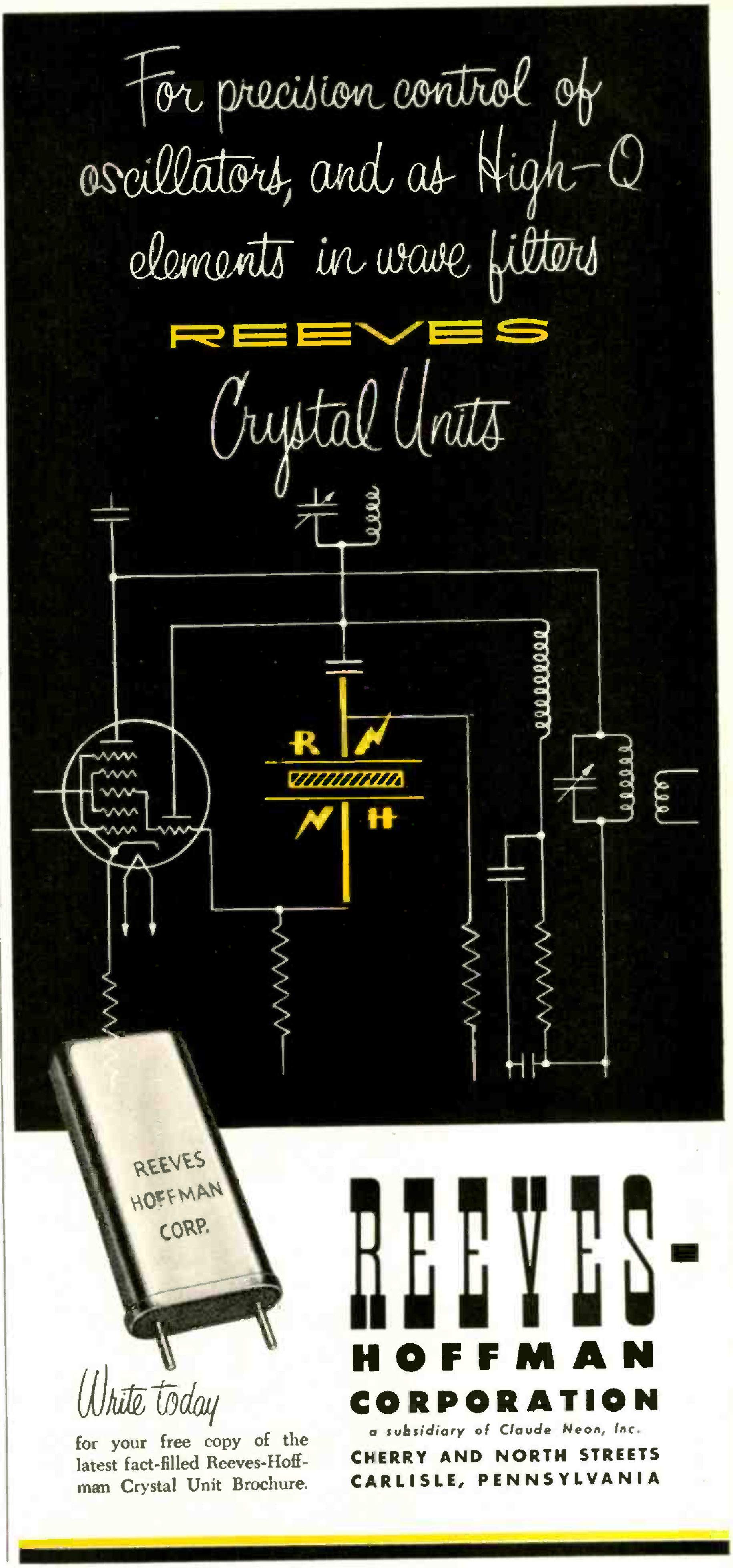


FLARE MACHINE
operates automatically

KAHLE ENGINEERING CO., 1492 Seventh St., North Bergen, N. J., has available model 2310 automatic flare machine for producing flared necks for c-r tubes. It uses standard lengths of tubing, automatically makes the flare, and cuts off to proper length. Two machines were formerly required for these operations. Cutting is by the hot-chill technique. By locking out the flaring mechanism the machine can be used as a glass tubing cutter and can produce all the cut tubing for stems, tubulations and necks used in electronic tube production. Incorporating ball-bearing construction, precision barrel cam index and forced feed oiling, the machine can operate 24 hours a day with a minimum of maintenance.

POTENTIOMETERS
are high resolution type

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y. Model HP-300 is a high resolution, low torque linear potentiometer enabling extremely fine settings and



For precision control of oscillators, and as High-Q elements in wave filters

REEVES Crystal Units

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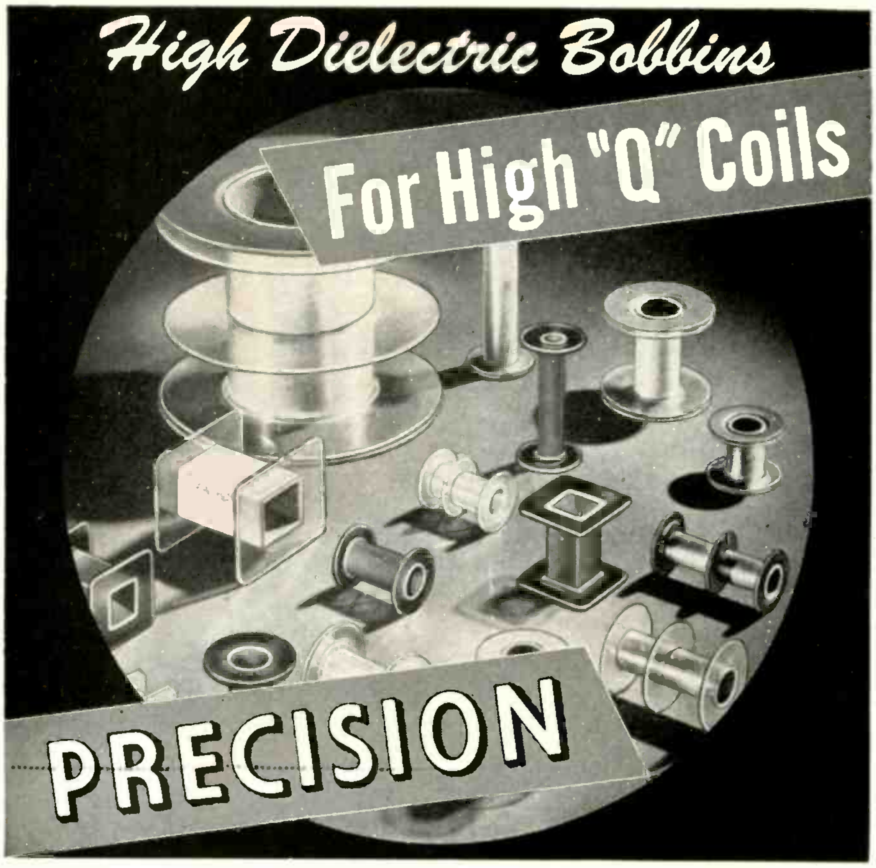

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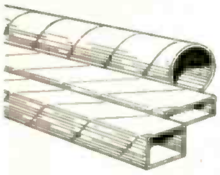
IN ANY SIZE • SHAPE • QUANTITY

Precision coil bobbins are fabricated from high dielectric materials and quality controlled to the most minute tolerances . . . Yet, because they are made on special high production equipment, they're available to you for prompt delivery at low unit cost.

Cores are spirally wound dielectric kraft, fish paper, acetate, phenol impregnated or combinations. Flanges are cut to any specification for all types of mountings.

Request illustrated bulletin. Send specifications for samples.

High Strength Low Cost Paper Tubes



Accurately fabricated in any size, shape, ID or OD. Spirally wound from select dielectric materials. Crush resistant, with excellent dimensional stability. Subject to rigid control and inspection for tolerance and uniformity.

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Indiana, Southern Ohio:
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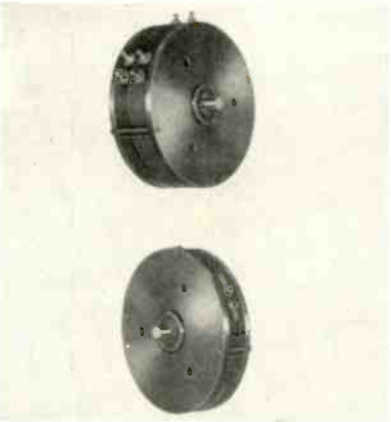
2041 W. CHARLESTON ST. CHICAGO 47, ILL.

Plant No. 2: 79 Chapel St., Hartford, Conn.



readings. A long winding length and a small diameter cylindrical Kohlrausch winding produce very high winding resolution. The HP-300 series is completely enclosed and designed for use as single or multiple ganged units. Up to 16 taps can be provided. Housings are one-piece molded of high stability Bakelite with precision turned, blue Alumilite finished end plates.

S-BAND WAVEMETER covers 2.3 to 4.5 kmc

AMERAC, INC., 116 Topsfield Road, Wenham, Mass. Model 229 S-band wavemeter is a coaxial-line type instrument covering the frequency range from 2.3 to 4.5 kmc. Among its features are (1) a precision-ground lead screw that helps give a high accuracy of measurement; (2) a cavity body made from a solid block, precision-machined to close tolerances, giving extreme mechanical stability; (3) the use of Invar in the line displacement portion, affording a high frequency stability throughout the temperature range of 10 C to 40 C; (4) tri-plating of all r-f surfaces; and (5) rugged electrical and mechanical components. Type N constant impedance coaxial connectors are used for both transmission and absorption inputs. The BNC or Selectar fitting provides external video connection. Power-handling capability by absorption method is from 0.5 mw to 1 w maximum; power-handling by transmission method is from 1 mw to 25 w peak power; approximate loaded Q is 2,000; and net weight is 4¾ lb.

VTVM
is a high-impedance unit

FREED TRANSFORMER CO., INC., 1715 Weirfield St., Brooklyn 27, N. Y. Model 1060 high-impedance vtvm is especially useful when making tuned circuit measurements at audio and supersonic frequencies. It combines these features: input impedance of 50 megohms in parallel with 25-$\mu\mu$f capacitor; accuracy of 2.0 percent on all ranges, with full-wave average reading meter calibrated in rms; and frequency range, 10 cps to 30 kc. Voltage range is 0.001 v to 100 v in 5 ranges. Effect of variation in line voltage from 100 to 125 v is less than 2.0 percent, while effect in changes of tubes is less than 0.5 percent. Logarithmic voltage scale is calibrated from 1 to 10 plus a linear decibel scale calibrated from 0 to 20 db.

HIGH POWER SOURCE
is a versatile unit

COMMUNICATION MEASUREMENTS LABORATORY, INC., 350 Leland Ave., Plainfield, N. J. Model 1447 variable frequency variable phase electronic generator was developed to meet the need for a power source for use in the development and testing of 3-phase airborne electronic equipment. It consists of one model 1445 generator using one exciting phase

Winchester Electronics

ONE SOURCE
OF
Printed Circuit
CONNECTORS

for ALL
your needs...

"K2" "K3"
For individual or combination use.
2-Contact 3-Contact

"K"
2, 3, 6, 10, 15, 18 & 22 5-Amp. Contacts
3500 vDC Breakdown Voltage

3 CONNECTOR STYLES

2 to 37 CONTACTS

5 TERMINAL TYPES

2 CONTACT SPACINGS
(3500 or 2500 vDC Breakdown Voltage)

2 CONTACT WIDTHS
(5-Amp. or 3-Amp. Rating)

"K" TERMINALS
Type "T" for Riveting to Circuit Card
Type "S" with Solder Cup
Type "W" for "Wire-Wrap"

"KM"
14, 21, 31 & 37 3-Amp. Contacts
2500 vDC Breakdown Voltage

"KM" TERMINAL
Slotted Eyelet will take 3 #20 wires.

"KKM"
6, 10, 12, 15, 18 & 22 3-Amp. Contacts
3500 vDC Breakdown Voltage

"KKM" TERMINALS
for "Wire-Wrap"
With Eyelet

These precision "printed circuit" connector receptacles and many variants of them, or others to your specifications, are the accepted standard . . . for quality, compactness, ruggedness, light weight and dependability.

"KKM" is ideal for low-cost commercial applications . . . mechanically interchangeable with comparable "K" type.

Wire or write for catalog of these and other types or advise us of your special requirements.

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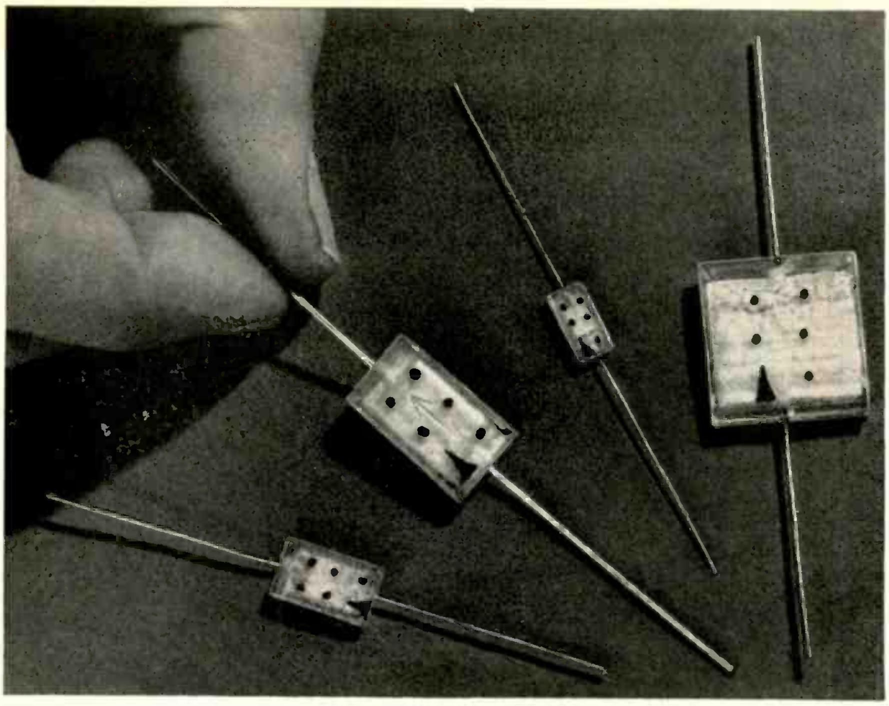


Miniaturization means fewer physical sizes to cover a large capacitance range. Non-wire lead capacitors can be made even smaller.

miniature – in size **only**

When your design says miniature and your specifications say quality — here's the combination...

The Corning Fixed Glass Capacitor is approximately one third smaller than other kinds of equal capacity. In performance, the Fixed Glass Capacitor has most of the advantages of mica—plus some special features of its own.

You'll find a lot about their performance in the way they're made. Layers of conductor and dielectric are *sealed together* at high temperature and pressure to form a rugged monolithic unit. The seal cannot be altered nor can properties be changed short of destroying the capacitor.

You can use Corning Fixed Glass Capacitors at temperatures to 125° C. and higher, with proper voltage de-rating. The temperature coefficient remains the same after repeated temperature cycles and it is held within narrow limits over a wide temperature range with very little variation between capacitors. Capacitance drift is close to zero. Usually it's less than the error of measurement.

Moisture can't enter these Fixed Glass Capacitors. Insulation resistance is high. Dielectric absorption is low.

And you can get a variety of sizes and shapes. Because of its unique construction, the Corning Fixed Glass Capacitor allows wide latitude of equipment design. We can make capacitors to your electrical and physical specifications. What's more, single, self-supported units can be designed for high voltages or high capacitances. Series parallel combinations extend the range still further.

For more information about the remarkable advantages of Corning Fixed Glass Capacitors, please write, wire or phone us.

CORNING GLASS WORKS • CORNING, N. Y.
New Products Division
Corning means research in Glass

from a model 1440 three-phase oscillator. Two model 1446 generators with single phase internal oscillators developing 4.5 kva each complete the system. The model 1447 develops 13.5 kva of power into a resistive load through a frequency range of 50 to 6,000 cycles. Any desired phase relationship can be set up as the 3 outputs of the model 1440 master oscillator have phase shift controls which are adjustable through the full 360 degrees.

MOBILE RADIO UNIT
for 450-470 mc operation

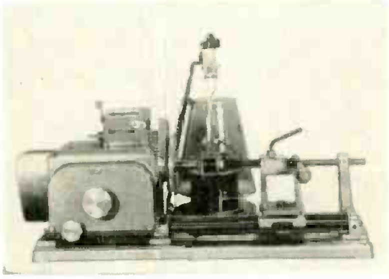
ALLEN B. DUMONT LABORATORIES, INC., 750 Bloomfield Ave., Clifton, N. J., has announced a complete radio system for operation in the uhf 450 to 470-mc band. The type MCA-401A system is rated at 12 w at 450 to 460 mc and 10 w at 460 to 470 mc. A high-efficiency, plug-in power chassis requires minimum primary power. A high degree of stability is maintained through the use of the latest type crystal oscillators. Economical operation is assured by use of low-cost tube types, long-life selenium rectifiers and and other components of proved service records. A special uhf antenna transfer relay improves r-f transfer efficiency. Uhf tv interference is minimized by means of a low-pass filter employed in both receiver and transmitter.

MINIATURE RELAY
is hermetically sealed

BRANSON CORP., Boonton, N. J., announces a new miniature relay for aircraft and missile application with dimensions approximating those of miniature tubes. Useful at

MRH-3102
BOONTON, N J
ELECTRON

50 g shock and 20 g vibration up to 500 cps, the type MRH provides 2-ampere contacts in dpdt combinations. It is available for use at ambients of 85 C or up to 200 C for special purposes. All contact insulation is ceramic and glass, which makes the relay very useful in high-frequency switching applications. The type MRH occupies a volume of 0.75 cu in. and weighs 1.4 oz. Coil resistances up to 10,000 ohms are available.



BOBBIN WINDER features adjustable cam

GEO. STEVENS MFG. CO. INC., Pulaski Rd. at Peterson, Chicago 30, Ill. Model 319-AM bobbin winder winds all types of random wound bobbin coils, solenoids, repeater coils and precision noninductive resistors from 0 to 2½ in. wide and 5½ in. outside diameter. An outstanding feature is the built-in adjustable cam. Calibrations allow instant adjustment of winding traverse to the desired winding width. Another feature is the submergence of the internal gears in a permanent oil bath, resulting in smooth operation and reduced wear. It also has built-in dual power take-offs, a positive stopping magnetic brake, and a time-saving automatic counter that permits instant resetting of the

BALLANTINE

BATTERY OPERATED ELECTRONIC VOLTMETER

VOLTAGE RANGE:
100 microvolts to 100 volts rms of a sine wave in 6 decade ranges.

INPUT IMPEDANCE:
2 megohms shunted by 8 mmfd on high ranges and 15 mmfd on low ranges.

FREQUENCY RANGE:
2 cps to 150,000 cps.

ACCURACY:
3%, except 5% below 5 cps and above 100,000 cps.

MODEL 302B
Size: 6⅞" x 7½" x 12⅜".
Weight: 14 lbs.
Price complete with cover and batteries: $215.

- Available accessories increase the voltage range from 20 microvolts to 42,000 volts.
- Available precision shunt resistors permit the measurement of AC currents from 10 amperes down to one-tenth of a microampere.
- Features the well-known Ballantine logarithmic voltage and uniform DB scales.
- Battery life over 100 hours.
- Can also be used as a flat pre-amplifier with a maximum gain of 60 DB. Because of the complete absence of AC hum, the amplifier section will be found extremely useful for improving the sensitivity of oscilloscopes.

For further information on this Voltmeter and the Ballantine Model 300 Voltmeter, Wide-Band Voltmeters, True RMS Voltmeter, Peak to Peak Voltmeters and accessories such as Decode Amplifiers, Multipliers, Precision Shunt Resistors, and Precision Sensitive Inverter, write for catalog.

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100 FANNY ROAD, BOONTON, NEW JERSEY

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MS (Military Standard)
MIL-T-27 400 Cycle
Pulse Transformers
Molded Toroidal Inductors
High Fidelity Transformers
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These are just a few of the popular types of transformers for military, new equipment, general replacement, control and power circuit applications listed in CHICAGO's new Catalog . . . over 500 transformers, with complete physical and electrical specifications on each unit.

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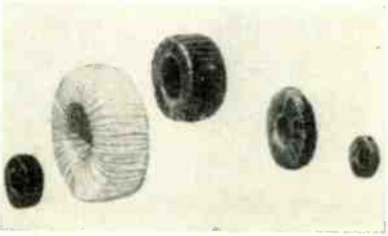
winding cycle by merely touching a lever. Winding speed is up to 7,000 rpm.



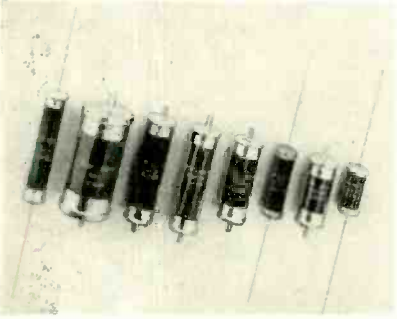
TOROIDAL COILS
meet close tolerances

UNIVERSAL MFG. CO., INC., Michigan & Monroe Aves., Kenilworth, N. J., has announced toroidal coils that meet exacting design requirements. Sizes range from 1 in. i.d. with No. 17 wire and 2 in. i.d. with No. 10 wire. Coil sizes range from ¼ in. i.d. to 10 in. i.d.—height to 3½ in. Wire sizes No. 10 (0.1019 in.) to No. 42 (0.00249 in.) have been handled efficiently on production runs with 100-percent turns accuracy or an inductance of ±2 percent. These toroidals are wound, impregnated and cased (if required) to customer or MIL-T-27 specifications.

SPEED REDUCERS
of small size and weight

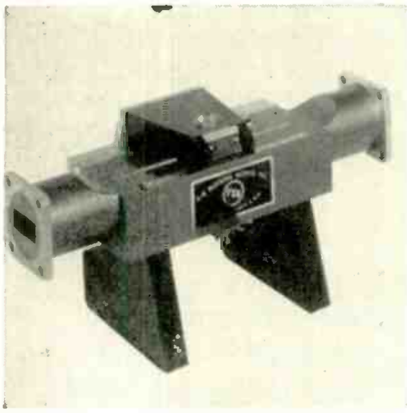
BOWMAR INSTRUMENT CORP., 2415 Pennsylvania St., Ft. Wayne, Ind., has announced a new series of precision miniature speed reducers for general laboratory and product design use. Two basic units, 1062 and 1687, measure 1.062 and 1.687 in. in diameter respectively, and 1.656 and 1.859 in. in length, exclusive of shaft length, which can be specified. Ratios range from 12.5 to 10,000-to-1. Specifications include backlash of less than 0.5 deg. Series 1062 is designed for output torque loads up to 25 oz. in.;

1687 is rated at 100 oz in. maximum. Both units feature ABEC class 5 ball bearings throughout. They are especially applicable for electronic controls, actuators, servos and similar equipment where very small size and weight are vital factors.



CAPACITORS
are glass tubular type

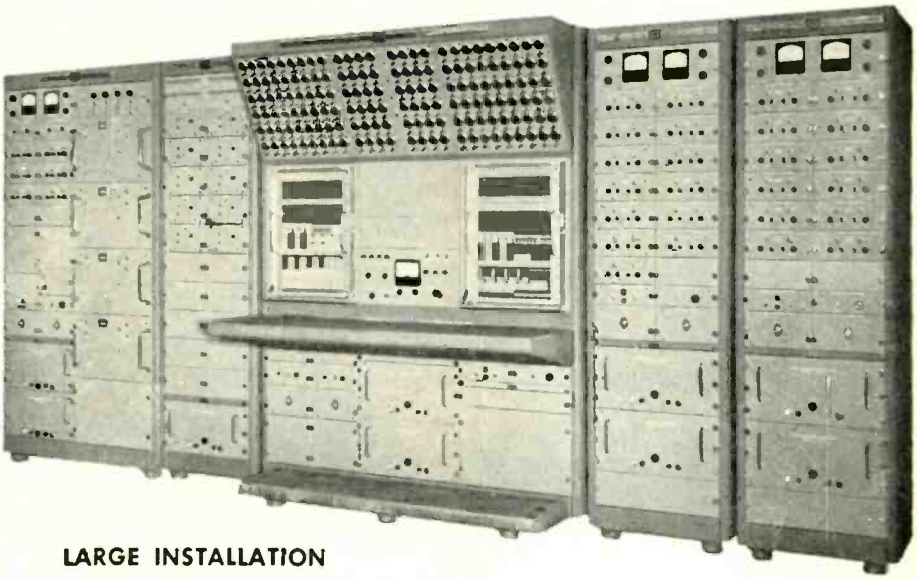
CORSON ELECTRIC MFG. CORP., 540 39th St., Union City, N. J., has available a new line of glass tubular plastic dielectric capacitors, type G-6 Glascaps. The units feature light weight and compactness not attainable in other types of capacitors and are particularly useful in high-voltage d-c, and low-frequency, low-voltage a-c applications. They are available in a complete range of ratings from 0.01 μf at 600 v through 0.0015 μf at 60,000 v. All sizes are available from stock for immediate delivery.



SLOTTED SECTIONS
from 2,600 to 40,000 mc

F-R MACHINE WORKS, INC., 44-14 Astoria Blvd., Long Island City 3, N. Y. Type 100A series of microwave slotted sections feature: (1) tapered slot for low residual vswr; (2) stable carriage movement for

MODERN Problems Demand... MODERN SOLUTIONS

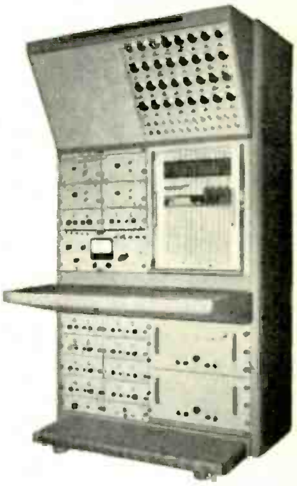


LARGE INSTALLATION

This large computer is used for the rapid solution of aero-dynamic problems. It consists of 50 operational amplifiers, 10 servo multiplying channels, 4 resolving channels, and a control console with two pre-patch bays, 156 attenuators, two voltmeters, and all necessary operational controls.

SINGLE PACKAGE COMPUTER

Our Type 16-31R Computer is a single package computer capable of solving differential equations with many simultaneous elements which are often encountered in the simulation of dynamic systems. It contains 20 operational amplifiers, 4 servo multipliers, thirty-two attenuators, all-metal removable problem board, and complete control panel.



PLOTTING EQUIPMENT

For presentation of problem solutions, the Variplotter Plotting Boards provide an accurate inked record. Typical uses include the automatic plotting of: Analog Computer output; guided missile data; engine performance characteristics; and control of manufacturing processes. With accessory equipment the range of applications can be greatly extended.

WRITE DEPT. E

ELECTRONIC ASSOCIATES Incorporated

ELECTRONIC ASSOCIATES INC
LONG BRANCH • NEW JERSEY

NEW SIGMA RELAY DESIGNED FOR MODEL AIRPLANE REMOTE CONTROL

The new Sigma 26F 8000-CDS Relay was designed to provide certain advantages over the 4F, now a popular remote control relay. How well this objective has been realized remains to be seen. On paper, however, it looks like this:

Coil resistance 8000 Ohms ± 10% at 20°C

Pull-on current 0.6-0.7 madc (Factory setting. What you do is your own business)

Difference between pull-on and drop-out 0.1-0.2 madc

Weight 2 oz.

Shock immunity 100 G (without damage)

As compared to the 4F, the 26F is slightly smaller, ¼ ounce lighter and is more resistant to vibration and shock. Its major hope is the lower operating current and differential which means longer battery and tube life. Cost is slightly more than the 4F.

SIGMA

SIGMA INSTRUMENTS, INC.
PEARL STREET, SO. BRAINTREE, BOSTON 85,

APPEARING IN MODEL AIRPLANE NEWS

Model airplane enthusiasts use miniature radio transmitters and receivers for remote control of models in flight. An important component of the receiver is a sensitive relay. For years the Sigma type 4F has been a favorite for this purpose — by chance rather than by design.

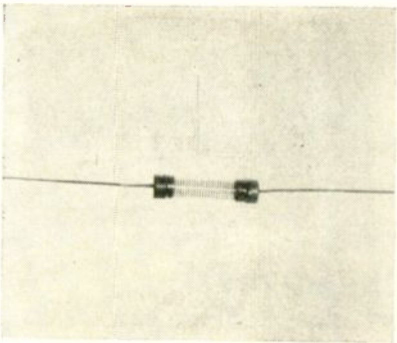
Normally we wouldn't bother with a *special* design for such an application, but some of our boys play with model airplanes and the rather lavish praise that model airplane magazine editors have had for the 4F made us think it about time to design one that *we* could really feel was good for models.

We justify this sort of thing by recalling that these people grow up and get jobs (where they *may* specify relays).

SIGMA

SIGMA INSTRUMENTS, INC., 62 PEARL STREET, SO. BRAINTREE, BOSTON 85, MASS.

true readings; (3) precision ball bearing action for low wear; (4) easy fingertip control. The waveguide and coaxial sections are milled from solid aluminum blocks and the ball-bearing races are ground from oil-hardened steel. The units are available in all waveguide sizes from 2,600 to 40,000 mc.



PRECISION RESISTOR
is hermetically sealed

BALCO RESEARCH LABORATORIES, 49–53 Edison Place, Newark 2, N. J. A new type of precision resistor utilizes a pure noble-metal film coated on the inside of a rugged, heat-resistant glass tube. The resistor is hermetically sealed. Characteristics are its high stability, low temperature coefficient, negligible reactive effects (out to 10 mc) ruggedness and compactness. The typical 1-w size measures 1 in. long and $\frac{5}{16}$ in. overall diameter. Ratings of ½ w, 1 w and 2 w are available in values from 10 to 100,000 ohms (higher values on special order) and tolerances of 1 percent, 0.5 percent and 0.25 percent. Popularly priced precision resistors, they exceed the requirements of MIL-R-10509A.

NETWORKS
of twin-T rejection type

WHITE INSTRUMENT LABORATORIES, 203 Riverside Drive, Austin 4, Texas. The series 500 networks of standard R-C twin-T rejection type, are now available in hermetically sealed enclosures. Stable components with low temperature coefficients insure stability with time and temperature. Circuit parameters are selected for optimum notch sharpness and voltage output, with

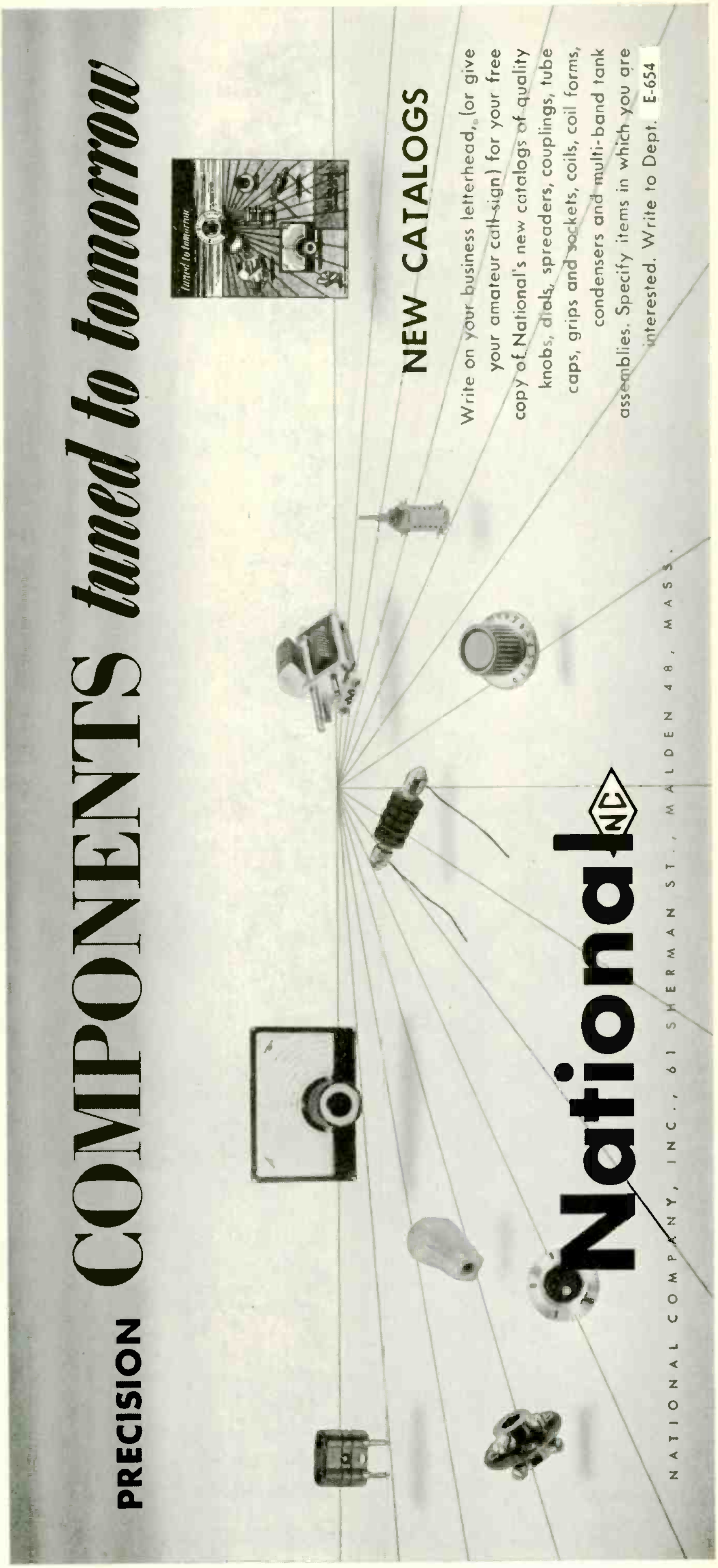
White
INSTRUMENT
LABORATORIES
AUSTIN, TEXAS

impedance levels permitting matching to typical circuits. All of the standard and many special null frequencies are available. Bulletin 500 gives full engineering information.

5687
DUAL CATHOD
FOLLOWER
TYPE: M1523
WALKIRT

CATHODE FOLLOWER
is tiny, dual-type

THE WALKIRT CO., 145 W. Hazel St., Inglewood, Calif. Type M1523 is an improved, high-efficiency, dual-type cathode follower specially designed for coupling low output impedances with high input impedances. It is miniature resin encapsulated and designed for plug-in operation. The unit is ideally suited for joining high-impedance sources, such as flip-flop oscillators and voltage amplifiers, with low-impedance devices such as transmission lines, matrices, filters, or capacitive circuits where fast rise times are desired. The dual feature allows extreme versatility. Each cathode output impedance is 100

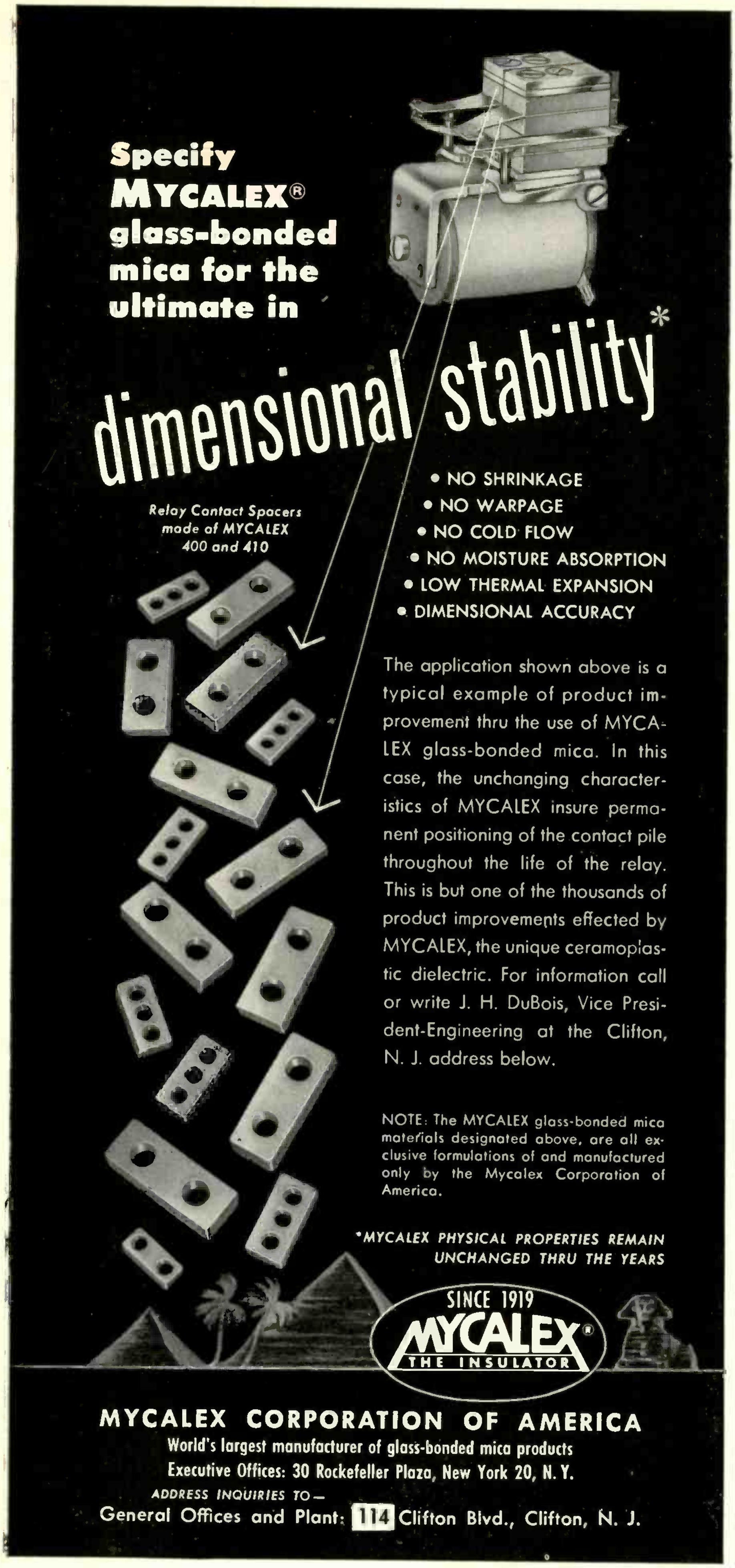

PRECISION COMPONENTS *tuned to tomorrow*

NEW CATALOGS

Write on your business letterhead, (or give your amateur call-sign) for your free copy of National's new catalogs of quality knobs, dials, spreaders, couplings, tube caps, grips and sockets, coils, coil forms, condensers and multi-band tank assemblies. Specify items in which you are interested. Write to Dept. E-654

National NC

NATIONAL COMPANY, INC., 61 SHERMAN ST., MALDEN 48, MASS.



Specify
MYCALEX®
glass-bonded
mica for the
ultimate in

dimensional stability*

Relay Contact Spacers
made of MYCALEX
400 and 410

- NO SHRINKAGE
- NO WARPAGE
- NO COLD FLOW
- NO MOISTURE ABSORPTION
- LOW THERMAL EXPANSION
- DIMENSIONAL ACCURACY

The application shown above is a typical example of product improvement thru the use of MYCALEX glass-bonded mica. In this case, the unchanging characteristics of MYCALEX insure permanent positioning of the contact pile throughout the life of the relay. This is but one of the thousands of product improvements effected by MYCALEX, the unique ceramoplastic dielectric. For information call or write J. H. DuBois, Vice President-Engineering at the Clifton, N. J. address below.

NOTE: The MYCALEX glass-bonded mica materials designated above, are all exclusive formulations of and manufactured only by the Mycalex Corporation of America.

*MYCALEX PHYSICAL PROPERTIES REMAIN UNCHANGED THRU THE YEARS

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THE INSULATOR

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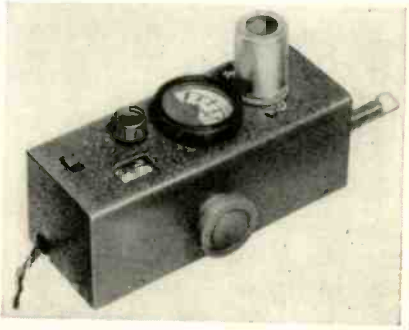
Executive Offices: 30 Rockefeller Plaza, New York 20, N. Y.
ADDRESS INQUIRIES TO—
General Offices and Plant: 114 Clifton Blvd., Clifton, N. J.

ohms, tapped at 1,000 ohms, with the signal amplitude at the tap approximately 65 percent of the cathode signal amplitude. Output impedances of approximately 50 and 500 ohms are available by paralleling the two sections.

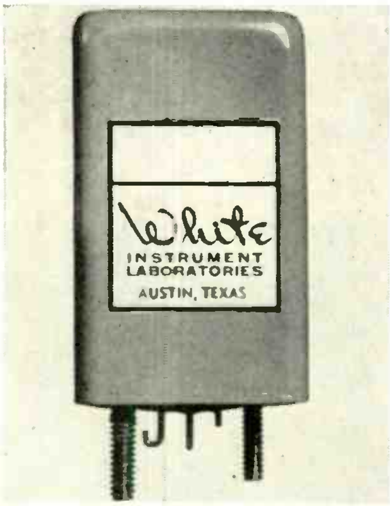


GRIP-DIP METER
for use in uhf-tv band

Linear Equipment Laboratories, Brightwater Place, Massapequa, L. I., N. Y. Model U-4 is a new type grid-dip oscillator-wavemeter specifically designed for use in the uhf-tv band. It covers the 450 to 900-mc range, which is in excess of that allocated for uhf video transmission. The tuning element uses a low loss cavity which is resonated to the desired frequency by means of a split-stator type capacitor. No wiping or sliding contacts of any kind are used. Coupling to the resonant cavity is accomplished by the use of a small external loop which, in itself, is not part of the tuned circuit. The unit is so designed as to permit ready access to other cavities, transmission lines, or virtually any type of uhf tuned circuit. A meter is provided for resonance indication.

LEAD NETWORKS
for servo amplifier use

White Instrument Laboratories, 203 Riverside Drive, Austin 4, Texas. The series 410 lead networks, now available in hermetically sealed enclosures, are resistance-capacitance filters for servo amplifier applications. Inserted in the d-c stage of a control amplifier, these networks combine lead or derivative action with high frequency and ripple filtering. The response is equiv-



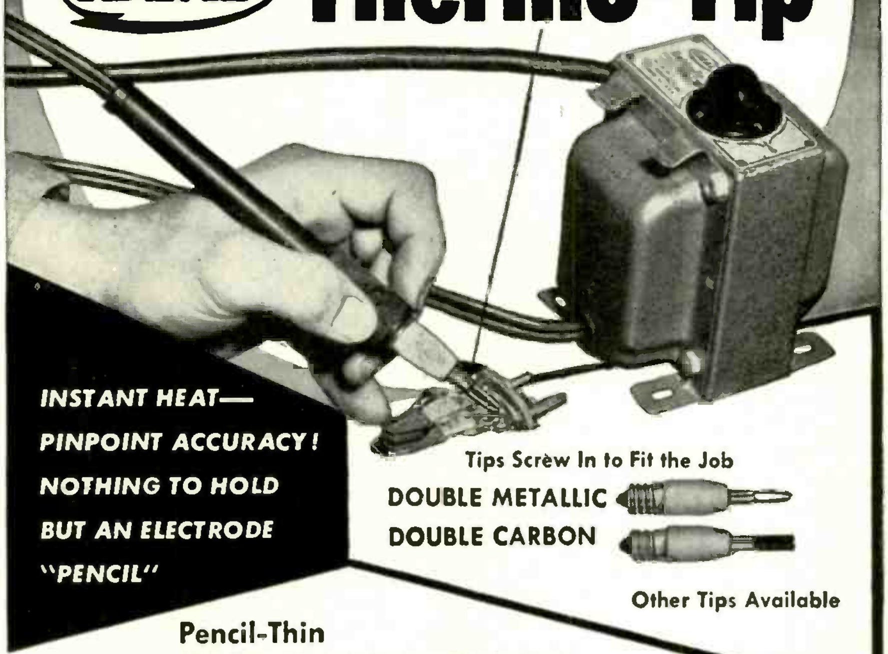
alent to the standard R-C rate circuit in the low-frequency control region. Beyond the control band the attenuation increases to reject unwanted signals. Full engineering data are available in bulletin 410.

IPOT
SION
L.1-HN
OMETER
ERING CO.

POTENTIOMETER
is hermetically sealed

FORD ENGINEERING Co., 129 East A St., Upland, Calif. This hermetically-sealed multiturn potentiometer, series H, has a diameter of 1 in. and weighs on 1¾ oz (10-turn unit, nitrogen filled). All static metal-to-metal joints are solder sealed. Rear header is solid metal with glass inserts through which the tin-dipped terminals project. The rotary seal design has been successfully tested at 100 psi at − 55 C and at 100 C and after 100,000 revolutions. These potentiometers have a power rating of 4 w at 40 C and a maximum torque between 0 C and 100 C of 2 oz in. Since

Now a NEW
"Pencil Point" SOLDERING TOOL
FOR SMALL OR MINIATURE WORK
IDEAL Thermo-Tip



INSTANT HEAT—
PINPOINT ACCURACY!
NOTHING TO HOLD
BUT AN ELECTRODE
"PENCIL"

Tips Screw In to Fit the Job
DOUBLE METALLIC
DOUBLE CARBON
Other Tips Available

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FOR EASIER, FASTER SOLDERING OF:

- Electronic Circuits and Parts
- Aircraft Connectors
- Pin Type Plugs
- Wire-to-Wire
- Terminals
- Radio and TV Chassis
- Instruments
- Printed Circuits

Here is an all-new production tool expressly designed to make small and miniature soldering simpler and surer than ever before. It is so fast that some joints can now be soldered in less than 1 second! . . . so much lighter and easier to handle than soldering irons or guns that a woman can use it all day long without fatigue! Check this unique combination of features against your job requirements:

GETS INTO SMALL, TIGHT SPOTS because of smaller electrode pencil.

NO HEAT DAMAGE—instant resistance heating makes sound joints before resistors, condensers, printed circuits, terminal fibre, etc., can be damaged. Pinpoints the heat!

NO "COLD FLOW JOINTS"—resistance principle *requires* that metal be heated before the solder will flow. Tap switch adjust heat as needed.
SAFE—soldering pencil uses harmless (6v) voltage and high amperage from separate step-down transformer.

LESS FIRE HAZARD—electrodes are hot only when in use.

LESS REPLACEMENT COST—only low cost electrodes to buy.

SOLD THROUGH LEADING DISTRIBUTORS

TIPS FOR EVERY SMALL JOB —2 sizes of double carbon, single carbon with ground clamp, double metallic. May also BE USED AS SOLDERING IRON —two sizes of chisel tip irons.

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provide performance that exceeds the demand

Hermetically sealed components that perform superbly and lastingly in airborne and ground applications.

Yours for the asking— a well-illustrated brochure describing Milwaukee transformers and production facilities.

YOU can get precisely what you want to meet the most stringent applications from Milwaukee Transformer Company. Every Milwaukee unit is made to exceed the requirements of the demand — be it military or commercial — and well over one thousand different transformers have been designed and built for our clients. Engineering, laboratory and production facilities are always ready to answer your call — whatever the need. Phone, wire or write without obligation.

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5231 N. Hopkins St., Milwaukee 9, Wis.

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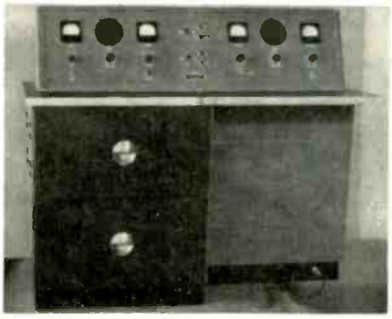
54-58 E. Quacker Street
Orchard Park, New York

neither moisture nor air can enter these units they are permanently free from electrical leakage and the effects of corrosion. Five-turn units, ¼ in. shorter than the 10-turn units, are also available.



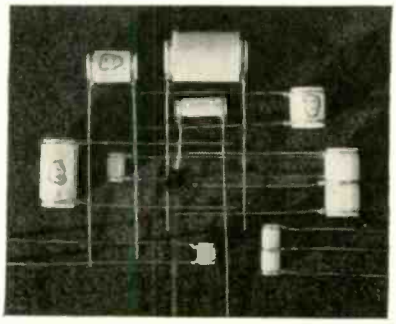
RADIO PAGING CONSOLE
is fully automatic

INDUSTRIAL ELECTRONICS, INC., 127 Light St., Baltimore 2, Md., is now in production on the new QSM radio paging control console. It was designed in answer to the demand for a simple, automatic compact piece of equipment fulfilling all the requirements of the radio paging operator. It records and repeats message sequences, remotely controls one or more paging transmitters, has a built-in field-strength and modulation meter and an automatic alarm that sounds if any part of the system fails. Fully automatic, it is normally operated by means of just one pushbutton.

6AS8
RCA ELEC TUBE
1"

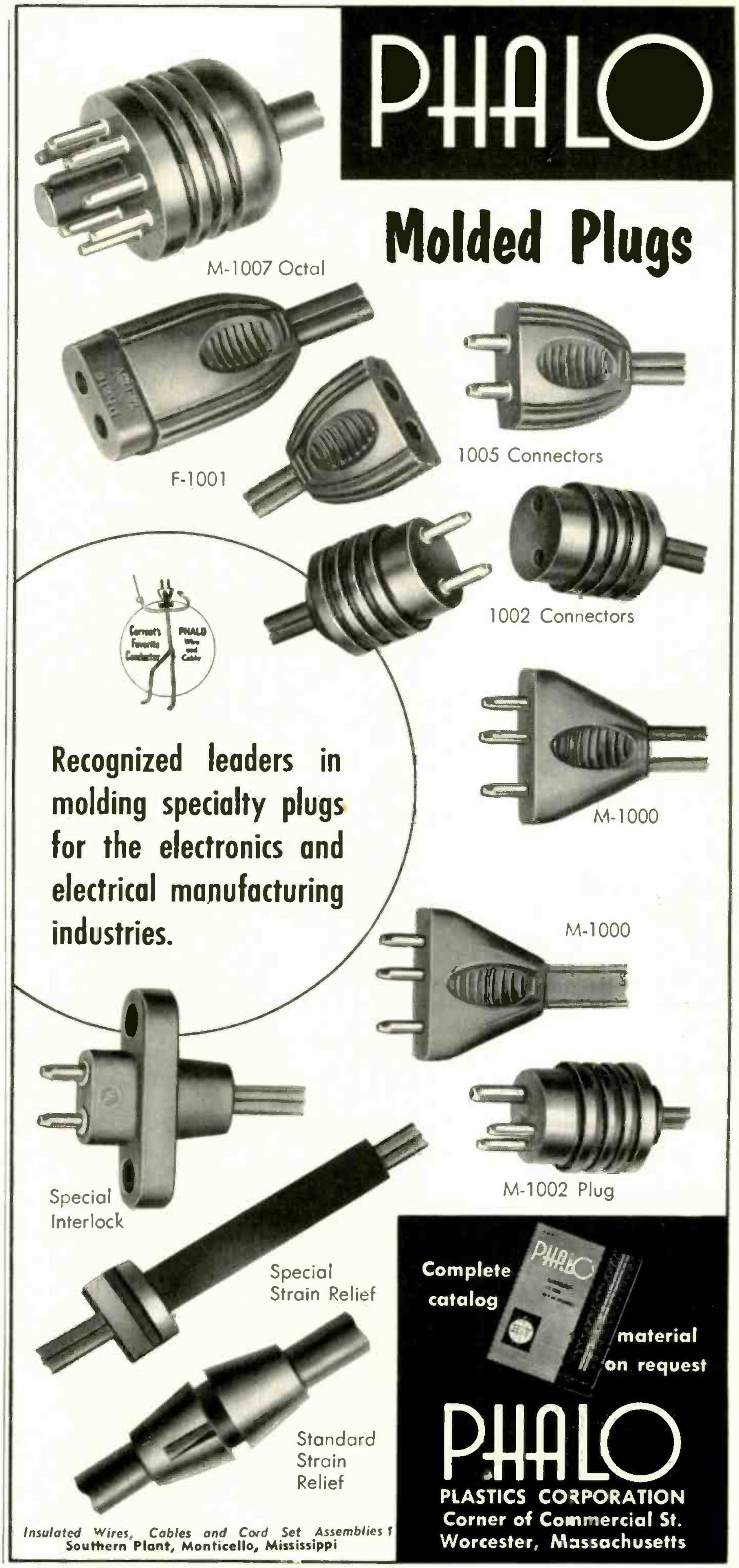
PENTODE
is multiunit tube

RADIO CORP. OF AMERICA, Harrison, N. J. The 6AS8 is a general-purpose, multiunit tube of the 9-pin miniature type containing a high-perveance diode and a sharp-cutoff pentode in one envelope. It is intended for diversified applications in tv receivers. The pentode unit with its high transconductance may be used as an i-f amplifier, video amplifier and agc amplifier. The separate grid-No. 3 base terminal facilitates the use of an unbypassed cathode resistor to minimize changes in input loading and input capacitance with change in bias without causing oscillation which might otherwise occur if grid No. 3 were internally connected to the cathode. The high-perveance diode, entirely independent of the pentode unit, is especially useful as a picture detector or d-c restorer. The base pins for the diode unit are arranged so as to reduce the capacitance between its plate and cathode.



RESISTORS
are precision noninductive

K-F DEVELOPMENT CO., 2634 Spring St., Redwood City, Calif. Available in exact resistance values to accuracies of 1 percent, 0.5 percent and 0.1 percent, a new line of precision resistors is offered in a series of standard value ranges from 0.1 ohm to 1 megohm. Wound noninductively on nonhygroscopic ceramic bobbins and impregnated for moisture protection, these units exhibit low thermal emf and a temperature coefficient of 0.000025 ohm per deg C. Nine sizes are supplied ranging in power capability from ¼ w to 1 w; in diameter from ¼ in. to ¾ in., and in length from 5/16 in. to 1¼ in. In the standard units, values under 800 ohms are wound of Manganin wire while values over 800 ohms are supplied in Evanohm. Special alloys can be used where their characteristics are required and also special units can be produced with resist-


PHALO

Molded Plugs

Recognized leaders in molding specialty plugs for the electronics and electrical manufacturing industries.

Complete catalog material on request

Insulated Wires, Cables and Cord Set Assemblies !
Southern Plant, Monticello, Mississippi

PHALO
PLASTICS CORPORATION
Corner of Commercial St.
Worcester, Massachusetts

JK GLASLINE crystal sets stability record* of

1 PART IN 100,000,000

opening new concepts of stabilized frequency control

*In test by a leading U S. Government Laboratory using a G12A 1000 Kc Crystal

NOT A "LABORATORY" CRYSTAL: This record was made by the reproducible type JK G-12A quartz crystal illustrated, using a precision oven, over a two week continuous test period. This stability, corresponding to a rate of change of less than one second in more than three years, challenges existing methods of measurement. Presented here are several crystal units from the ultrastable JK GLASLINE series. Write us for additional information.

JK GLASLINE G-12A

Frequency Range: 540 to 1600 kc
Stability: ±15 cycles or better, 0 to 50°C

RECOMMENDED for extreme precision frequency applications in the 1 mc region. Also F.C.C. Approved for broadcast use without temperature control.

JK GLASLINE G-9J

Frequency Range: 1 to 10 kc
Frequency Tolerance over range of −40 to +70°C:
Without circuit adjustment: ±.03%
With circuit adjustment: ±.02%

RECOMMENDED as a time base for electronic instrumentation, pulse time modulation systems, radar, sonar, computers, etc.

JK GLASLINE G-9

Frequency range: 4 to 500 kc and 1.2 to 5 mc

RECOMMENDED for frequency standards and master oscillators in the communications and wired carrier spectra. Also as time base for color television transmitters and digital frequency measuring systems.

"Crystals for the Critical"

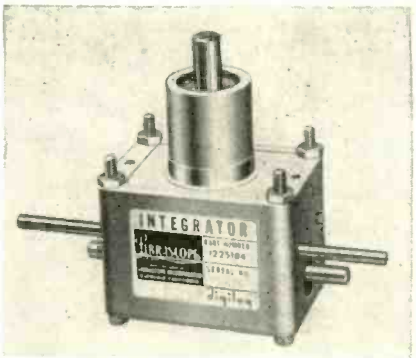
The James Knights Company
Sandwich, Illinois

JK PRODUCTS

ance values under 0.1 ohm and over 1 megohm.

ACCELEROMETER
is self-generating unit

General Scientific Corp., Los Angeles, Calif., has developed a highly compact self generating accelerometer especially designed to determine frequency and amplitude at high voltages. Despite its small size, the unit provides power output as high as 2 v, without external excitation. Sensitivity is as low as ± 0.003 g, and frequency response is from 2 to 350 cps. The unit operates with extreme accuracy at temperatures up to 550 F.

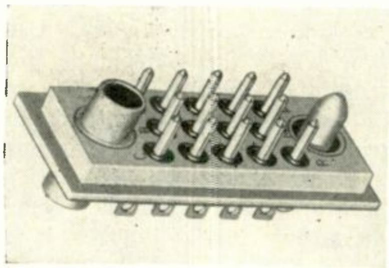


INTEGRATOR
with new oiling device

Librascope, Inc., 1607 Flower St., Glendale, Calif., has announced an improved ball and disk integrator for use in totalizing, rate determination, differential analyzers, or as a closed loop mechanical servo element or precision variable speed drive. Improvements include the addition of a permanent lubrication device which greatly increases the life of the unit, and the use of a lubricating oil which meets Army, Navy and Air Force specifications. Other specifications include: precision, 0.01 percent; width, 7⅞ in.; length, 3¾ in.; height, 3¼ in.; and weight, 21 oz. Superfinished balls and tungsten carbide disk are employed for high performance and long life.

PULSED RECTIFIER
of 9-pin miniature type

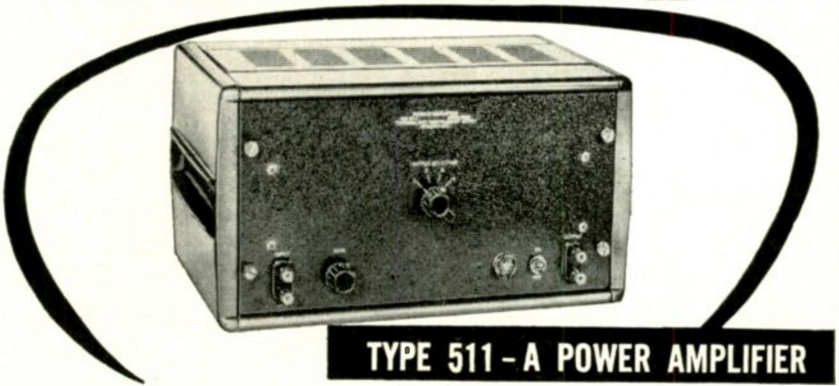
Radio Corp. of America, Harrison, N. J. The 3A2 is a half-wave vacuum rectifier tube of the 9-pin miniature type designed for rectifying the high-voltage pulses produced in the scanning systems of color tv receivers. Utilizing an indirectly heated cathode, the 3A2 is rated to withstand a maximum peak inverse plate voltage of 18,000 v. It can supply a maximum peak plate current of 80 ma and a maximum average plate current of 1.5 ma.

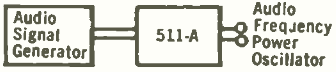


CONNECTORS
for sealed units

Viking Electric, 1061 Ingraham St., Los Angeles 17, Calif., has available miniature, hermetic-sealed rectangular connectors especially designed for electronic apparatus where sealed units are used. The new line, designated series HVT, features an all-glass seal

TIC nography of INSTRUMENTS





TYPE 511-A POWER AMPLIFIER

- PHASE SHIFT COMPENSATION
- NEGLIGIBLE DISTORTION
- HIGH VOLTAGE OUTPUT LEVEL

. . . a general purpose laboratory power amplifier featuring low distortion, low noise and excellent phase characteristics throughout the frequency range from 50 cps. to 50 kc. A choice of four outputs available to match various loads (5, 25, 200 or 1200 ohms). The 511A Power Amplifier is especially useful as a test driving source for tachometers, synchros, small motors, choppers, electro-mechanical devices and, with an audio frequency signal generator, as a power oscillator.

At rated frequencies and gain settings the overall phase shift is small. A special feature is the phase compensation circuit which permits the overall phase shift to be maintained at a constant value with varying gain. Harmonic distortion and intermodulation distortion are low. Output voltage up to 120 volts into a 1200 ohm load. Operates into loads varying from pure resistance to pure reactance.

The flexible system of phase shift control makes the 511-A Power Amplifier ideal for use in conjunction with phase measuring equipment as a power source in the investigation of phase characteristics of transmission lines, transformers, filters or equalizing networks, saturable reactors, magnetic amplifiers, and in acoustical measurements.

SPECIFICATIONS:

Output Characteristics and Gain (for 0.5% max. allowable harmonic distortion):

OUTPUT SELECTOR (Front Panel Control)	E_{out} Max.	Voltage Gain	Optimum Load	P_{out} Max.
Position 1	8 volts	1.4	5 ohms	12.8 W
Position 2	18 volts	2.8	25 ohms	13.0 W
Position 3	55 volts	8.0	200 ohms	15.1 W
Position 4	120 volts	21.0	1200 ohms	12.0 W

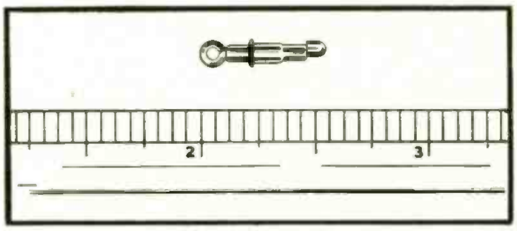
INPUT IMPEDANCE: 100 K ohms shunted by approximately 10 uuf.
FREQUENCY RESPONSE: At 10 watts or less output, essentially flat from 50 cps to 30 kc, down 0.5 db at 50 kc. At 10 to 16 watts, essentially flat from 50 cps to 30 kc, down 1.0 db at 50 kc.
HARMONIC DISTORTION: At 10 watts or less output, less than 0.5% total harmonic distortion (rms). At 10 to 16 watts output, less than 1.0% total harmonic distortion (rms).
PHASE SHIFT: 1.0° ±1.5° from 50 cps to 10 kc.
Phase shift may be compensated at any single frequency to remain constant for all gain settings. Phase shift may also be made zero for a single frequency and a single gain setting.
INTERMODULATION DISTORTION (rms): Less than 0.5% from 50 cps to 15 kc for difference frequency of 150 cycles.
OUTPUT REGULATION: ±5% of rated output voltage from optimum load to open circuit on all ranges.
HUM AND NOISE: Less than 15 mv. with input shorted.

TECHNOLOGY INSTRUMENT CORP.

533 MAIN ST., ACTON, MASS., ACton 3-7711

PHOTOCIRCUITS, INC. SELECTS
NEW HUBBELL *Interlock* TRADE-MARK
SUB-MINIATURE CONNECTORS
FOR WIRING PRINTED CIRCUITS!

Made for each other! Hubbell Interlock's sub-miniature connectors make wiring of printed circuits fast and safe. Note how Interlock Type "C" Connectors pass through set-in eyelets from back and lock automatically on opposite side. Eyelets manufactured by United Shoe Machinery Corp. Eyelet setting machines are available.



Hubbell Interlock sub-miniature Type "C" Connector. Simplicity of design is the key to its constant low contact resistance and ease of installation features.

Hubbell Interlock's latest development, the sub-miniature Type "C" Connector, featuring low contact resistance, automatic locking — quick disconnect wiring, found immediate application to another recent advancement in the electronic field — the "printed" circuit. The tiny connectors met every requirement for wiring the illustrated rotary switch plate circuit manufactured by Photocircuits, Inc. of Glen Cove, N.Y. Their automatic locking — quick disconnect feature eliminated difficult soldering and made possible fast, easy wiring maintenance. The exclusive Hubbell Interlock locking mechanism assured a vibration-proof, constant low contact resistance.
For Difficult Wiring Problems Requiring Sub-Miniature Connectors, Our Development Laboratory Will Cooperate With Your Engineers To Adapt Interlock For Your Specific Applications.

For Further Information, Write Dept. A:

HUBBELL

HARVEY HUBBELL, INC.
Interlock Dept., Bridgeport 2, Conn.

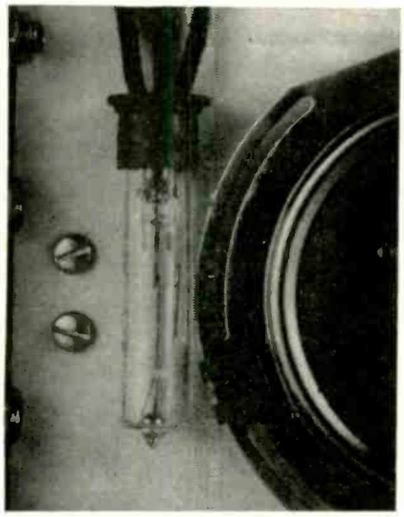
fused to each individual contact and to the body. In use, the connector, shaped to serve as a plug, is soldered into the top of the container which holds the component and its wiring. The glass seal prevents leakage in gas and fluid-filled units, and shuts out dust, air and moisture. These new-type connectors are especially useful with pressure-type of vacuum-type housings. The body of the hermetically sealed connector is precision-machined steel. Contacts and body are gold-plated over silver, for maximum conductivity, soldering ease and corrosion resistance. The series HVT connectors mate with standard VT receptacles and are available with 7, 14, 20 and 34 contacts. Other contact arrangements are available on special request.

TIMER
for spot or seam welders

VACUUM TUBE PRODUCTS, 506 South Cleveland St., Oceanside, Calif. Model F-216 fractional cycle timer is designed to meet the more specialized requirements of resistance welding when used for timing spot or seam welders, or other timing operations in industrial service where extreme reliability is required. The extremely fast time setting insures spatter-proof, oxide-free welds, and allows positive welding of such materials as molybdenum and tungsten. Positive adjustment in the fractional cycle range also allows welding of materials of less than 0.001 in. thickness with reliability and uniformity. The timer is packaged in a compact unit measuring 10½ × 9 × 10½ in. All controls are readily accessible from the front panel and consist of an on-off switch with pilot indicator, a cathode protection pilot, a high-low heat range switch and a variable time control. Peak current output of the standard unit is 40 amperes.

PENTODE AMPLIFIER
is color demodulator tube

WESTINGHOUSE ELECTRIC CORP., 401 Liberty Ave., Pittsburgh 30, Pa., announces a new pentode amplifier tube (type 6DB6) designed for use as a color demodulator synchronous detector in color-tv circuits. The 6DB6 is a sharp-cutoff pentode amplifier of the 7-pin miniature type. Grids 1 and 3 are control grids for color demodulation use. The chrominance signal is applied to grid 1 and the output of the 3.58-mc oscillator is applied to grid 3. The tube output, when used as a color demodulator, is linear for high levels of grid 3 drive. The 6DB6 may also be used as a sync separator with the accompanying advantages of a pentode-type tube. The tube can be used in black-and-white tv circuits as a mixer.

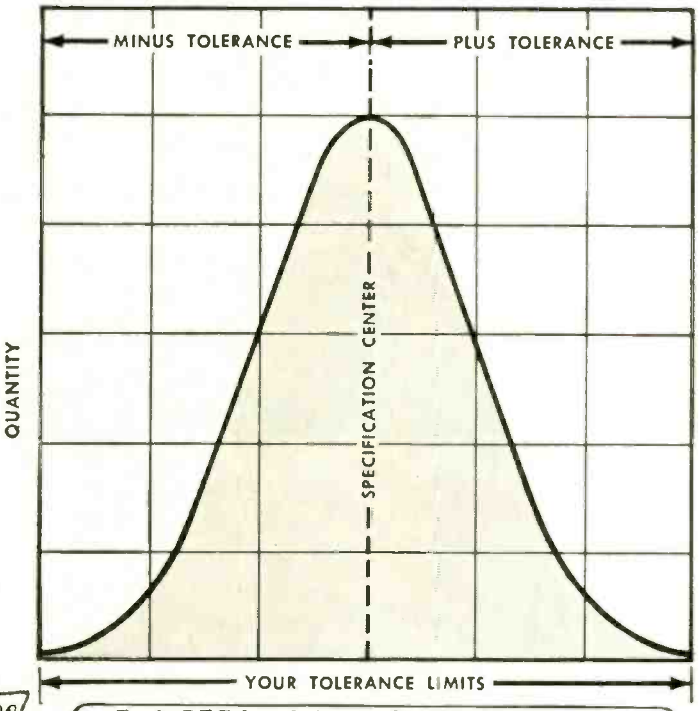


MERCURY SWITCH
requires very low loading

HAMLIN, INC., 1313 Sherman Ave., Evanston, Ill., has available a new hermetically sealed mercury switch which requires exceptionally low loading of the activating system. This provides for optimum accuracy when the switch is used as a position indicating and limit

This curve tells our story!

Centralab PEC's† are closer to your tolerance center than individual component assemblies



Each PEC batch in production is first 'pilot run,' then 'centered' on your tolerances.

...that's why Centralab PEC's are ***first*** in performance!

Chart above illustrates why CRL Printed Electronic Circuit networks give you *more for your money*. Based on normal distribution curve, the vast majority of CRL PEC's fall near the center of your tolerance limits. This assures highest performance . . . one *uniform* part instead of many, keeps unit costs low! Here's how Centralab controls PEC quality —

43 established quality control procedures constantly assure built-in *exact* high quality — for example:

- STEATITE OR DIELECTRIC PLATES — checked for dielectric constant, porosity, size, thickness, warpage.
- ASSEMBLY OF LEADS — checked for solder bond strength, position of leads.
- CAPACITOR PAINTING — checked for capacity values.
- RESISTOR PAINTING — checked for resistance values.
- FINAL TEST — checked for performance, voltage breakdown, insulation resistance.

TODAY — write for complete file of PEC data sheets.

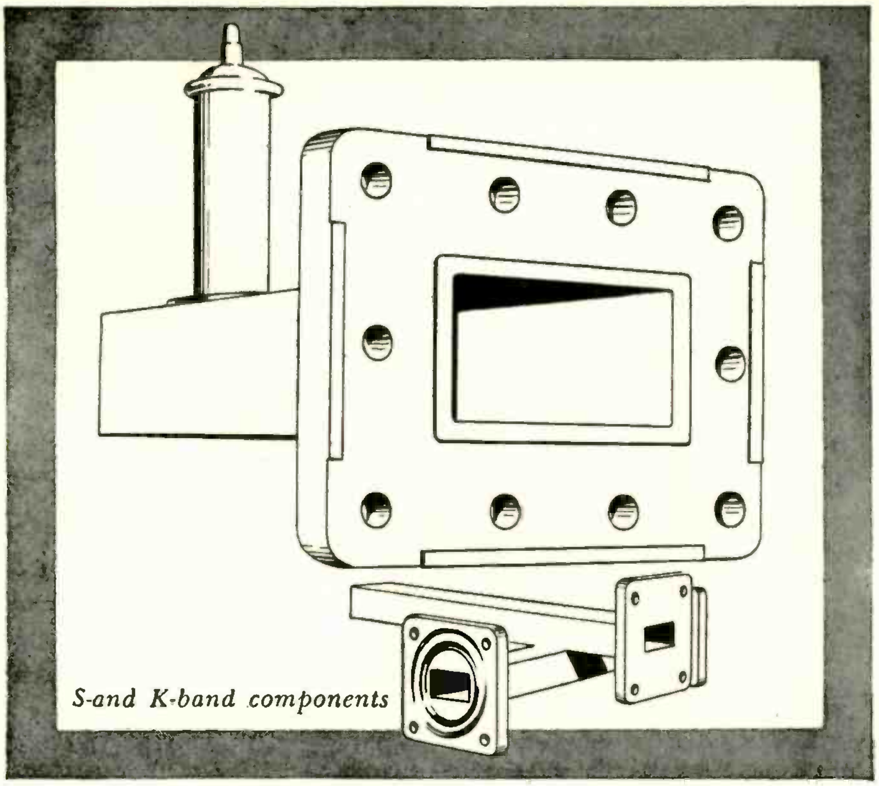
†Trademark

Centralab
A Division of Globe-Union Inc.
914-G E. Keefe Avenue • Milwaukee 1, Wisconsin
In Canada: 804 Mt. Pleasant Road, Toronto, Ontario

VARIABLE RESISTORS · SWITCHES · CERAMIC CAPACITORS · PRINTED ELECTRONIC CIRCUITS · CERAMIC INSULATORS

Industry's greatest source of standard and special electronic components

Y-4



how small can a wave guide get?

Well, alongside some of the stuff we're working with now, the radar plumbing we used during World War II gets to look like air-conditioning duct. What's more, some of our boys here seem to regard anything below S-band as practically pure D.C. Naturally, we're up to our hips as usual in work on military equipment. However, we do occasionally have some extra creative capacity available, so if you have a problem involving something special in wave guide components (real small ones, too) and like that, maybe we can help. Drop us a line.

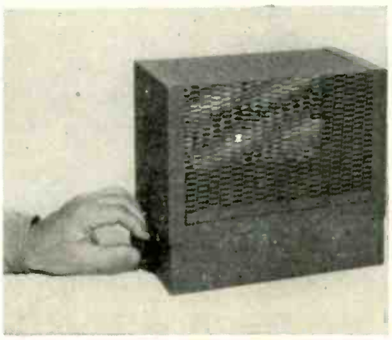
L. H. TERPENING COMPANY
DESIGN • RESEARCH • PRODUCTION
Microwave Transmission Lines and Associated Components
16 West 61st St. • New York 23, N. Y. • Circle 6-4760
TRADE MARK

switch in conjunction with precision equipment. Enclosed in a glass tube, all contacts are visible for quick inspection. The switch is a spdt magnetically actuated mercury type. As a small moving magnet approaches the armature within the switch, the electrodes are moved in and out of the mercury. No mechanical friction is involved. Standard operating ranges are from 12 v at 0.25 ampere to 120 v at 1 ampere.

RESEARCH ELECTRONICS
ROSLYN PA.

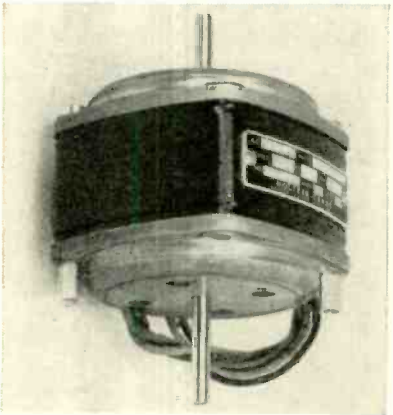
D-C VTVM is a package unit

RESEARCH ELECTRONICS LABORATORY, Roslyn, Pa., has released a new package d-c v-t voltmeter unit that transforms any standard 1-ma d-c meter into a high-impedance voltmeter or microammeter. All connections are made through the octal plug-in base, and it is particularly adaptable to building into testing equipment. The unit is designed for 95-125 v a-c, 60-cycle operation.



FOUNDATION CHASSIS for electronic applications

INSULINE CORP. OF AMERICA, Manchester, N. H. A series of five new foundation chassis, suitable for amplifiers, transmitters, power supplies and other electronic applications, has been introduced. The units feature perforated covers that provide both ventilation and protection for parts mounted inside. Made of heavy steel, the chassis depth is 3 in. Overall dimensions of the five models are as follows: No. 3965—5½ × 10 × 9 in.; No. 3966—8 × 12 × 9 in.; No. 3967—7 × 17 × 9 in.; No. 3968—10 × 14 × 9 in.; and No. 3969—10 × 17 × 9 in. Special sizes are obtainable to order.



SYNCHRONOUS MOTOR
is rated 0.3 oz in. torque

Holtzer-Cabot Motor Division, National Pneumatic Co., Inc., 125 Amory St., Boston 19, Mass., announces introduction of a polarized synchronous motor which always pulls into synchronous speed with the rotor in the same position with respect to polarity of the motor field. This motor, designated RBCP-2510, is rated 0.3 oz in. torque, 3,600 rpm, continuous 40-deg C rise for use with 115 v, a-c, 60-cycle, 12-w input.

Literature

Microphone Sensitivity Conversion Chart. Shure Brothers, Inc., 225 W. Huron St., Chicago 10, Ill. As an aid in the interchange of values of the three most commonly used systems, the company has issued a microphone sensitivity conversion chart with an explanatory guide. This easy-to-read nomograph

6 PDT Style FM

6 PDT Style PM

4 PDT Style DM

6 PDT Style SM

NOW . . . a reliable line of miniature relays!

● UNION TYPE M RELAYS* are the solution for those applications that require small size relays capable of providing reliable operations under conditions of high and low temperatures, severe shock and vibration.

Compactly, precisely and ruggedly constructed, they were especially designed and developed to do a job where continuous performance is absolutely necessary. Under rigid test the Type M relay actually operated over one million times—and still remained in top working condition!

They meet all the requirements of Military Specifications MIL-R-5757 A&B, and are available in either 6-pole or 4-pole double-throw models—for plug-in or solder-lug connections.

HERE IS SOME TYPICAL PERFORMANCE DATA:

Service	Continuous
Shock	Energized—exceeds 50 G's for 10 milliseconds De-energized—40 G's for 10 milliseconds
Vibration	Up to 500 cycles at 10 G's acceleration
Life Expectancy	1,000,000 operations minimum
Contact Rating	2 amps. at 26.5 volts—resistive load (other contact ratings available)
Coil Resistance	Up to 6000 ohms (depending upon application)
Weight	3.75 ounces.

The relays illustrated represent a few of the many variations available.

GENERAL APPARATUS SALES

UNION SWITCH & SIGNAL

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY
PITTSBURGH 18, PENNSYLVANIA

NEW YORK CHICAGO ST. LOUIS SAN FRANCISCO

How **Berkeley** equipment helped solve a problem for Litton Industries
San Carlos, California

PROBLEM: Detection and counting of pulse failures in production testing of magnetrons. High accuracy, reliability, speed and simplicity of operation required.

SOLUTION: Litton engineers devised a system providing reference pulses corresponding to magnetron input and output pulses. These reference pulses are then compared in a coincidence circuit. When the magnetron fails to "fire," an output pulse is produced by the coincidence circuit. This "triggers" a BERKELEY Model 410 electronic counter. Number of pulse failures during test interval is accurately recorded in direct-reading digital form.

RESULTS: BERKELEY equipment made possible positive detection of mis-fires and assisted in identification of the cause. Resulting design improvements produced a magnetron of exceptional reliability at lower cost. The simplified test procedure made efficient production rates possible; relatively unskilled operators are used, releasing higher technical skills for research and development work.

MAY WE HELP SOLVE YOUR PROBLEM? If it involves a faster, more accurate, easier and simpler way to measure frequency, flow, pressure, velocity, rpm., time intervals, viscosity – or high speed counting and counting plus preset control—chances are that BERKELEY can help you solve it. Complete data sheets covering many applications in these fields are yours for the asking – check coupon and mail it now!

M-31

Berkeley division
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Please send me application data sheets checked

Name
Title
Address
City State

MEASUREMENT OF:
☐ Pressure ☐ Velocity ☐ Flow
☐ Viscosity ☐ Operating Time ☐ RPM
☐ Frequency of

☐ COUNTING OR PREDETERMINED COUNTING OF:

CONTROL OF: ☐ Cutting Stock to Length
☐ Packaging and Batching

shows the relationship between open-circuit voltage response, open-circuit power response and the RETMA sensitivity rating. The chart is especially recommended for use by all those persons engaged in buying, selling, installing or using microphones. The relative ratings can be determined in a few seconds.

Precision Wire-Wound Resistors. The Daven Co., 191 Central Ave., Newark, N. J., has published a catalog intended as a guide to basic data on resistors for the application and designer engineer. It also presents, in the most concise and usable form, information on precision wire-wound resistors in adequate detail to permit their accurate selection and application for any specific purpose. The catalog includes new charts and data on resistance wire, Seald-Ohm, hermetically sealed and encapsulated types. The book is replete with engineering drawings and photographic illustrations. MIL and other government ratings are listed.

Magnetic Servo Amplifiers. Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N. Y., announces their new bulletin S235-1-54 summarizing in table form the standard line of 60 and 400-cps magnetic servo amplifiers. Also listed are magnetic amplifier servo systems and their servo performance. Many new amplifiers and servo systems have been included. The company also has available standard as well as specially designed magnetic voltage regulators for motor generator and motor alternator sets.

Microwave Dielectrometer. Central Research Laboratories, Inc., Red Wing, Minn., has published a 4-page brochure on the microwave dielectrometer. The unit described, designed to measure the dielectric constant and loss of a wide variety of materials at microwave frequencies, is pictured on the front of the literature, and a rear view of the dielectrometer with access door removed is shown on the inside. Graphs of the waveguide and a block diagram of the instrument are included with the specifications. Factual information and performance data on the theories and applications of the dielectrometer complete the brochure.

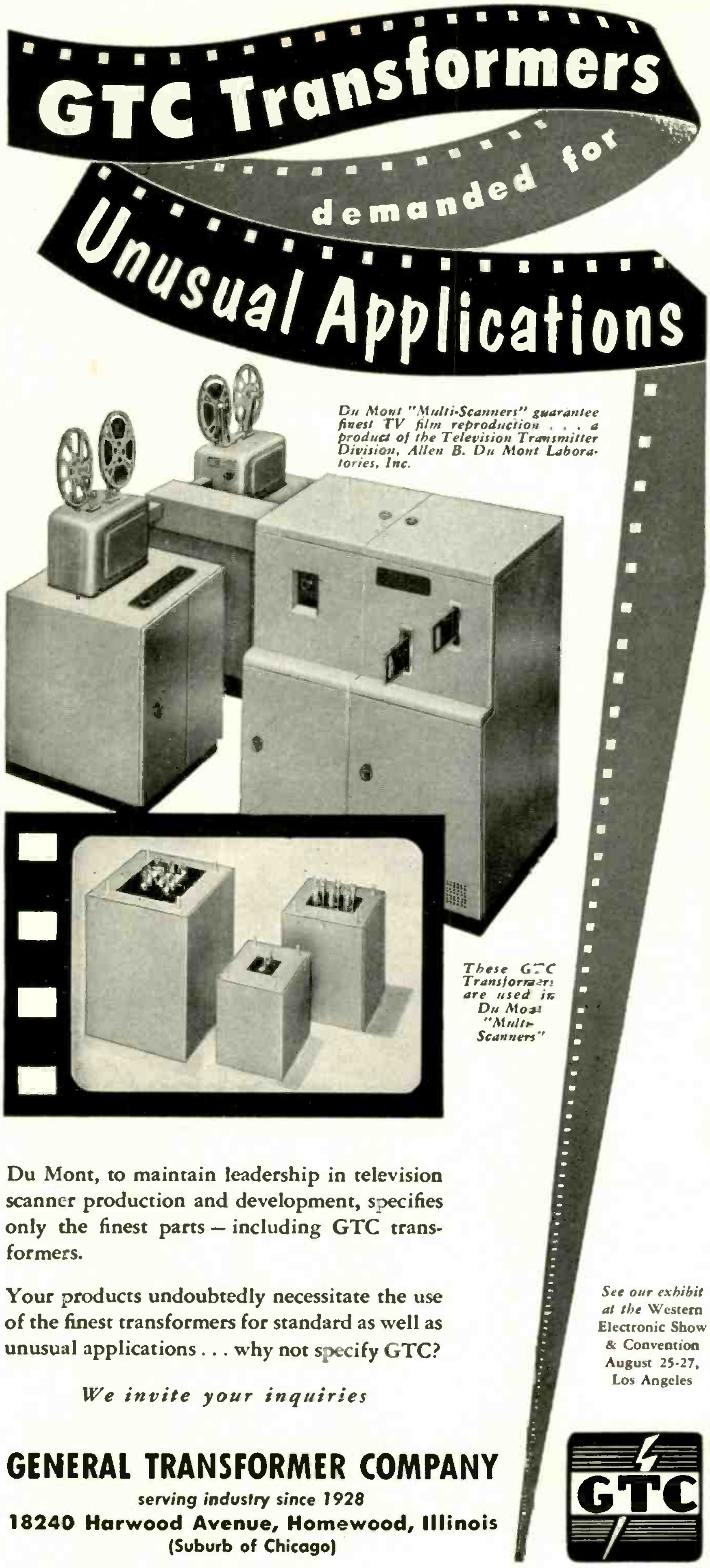
Electronic Components. I-T-E Circuit Breaker Co., 19th and Hamilton Sts., Philadelphia 30, Pa. Catalog R-200 is a new 36-page guide to the company's electronic components. It fully describes subminiature resistors, precision and power resistors, camera-and-receiver-type deflection yokes, focus coils, and i-f and r-f transformers and coils. Charts, tables, drawings, as well as selection and application information round out the contents of this useful book.

Computer Elements. Librascope, Inc., 1607 Flower St., Glendale, Calif., has available four catalog sheets on a line of computer elements. Items covered are a sine-cosine mechanism, a ball and disk integrator, a hollow shaft differential and read and record heads. Included in each sheet is an illustrated description, specifications, application information and dimensional drawing.

Dynamic Headphone. Telex Inc., Telex Park, St. Paul 1, Minn. A two-color, 8½ × 11 in. catalog sheet on the Dynaset, an under-the-chin dynamic headphone, has recently been published. The sheet lists specifications and advantages of this high fidelity, 1¼ oz. unit and explains its many professional, business and technical uses.

Synchro Instruments. Clifton Precision Products Co., Inc., Marple at Broadway, Clifton Heights, Pa., has published a 20-page, 2-color brochure titled "The Synchro Story." It describes in detail the materials, processes and operations going into the manufacture of a precision synchro instrument. Photographs and line drawings illustrate the text and show many of the operations from raw materials through final testing of the finished synchro instrument.

Replacement Transformers. Chicago Standard Transformer Corp., Addison and Elston, Chicago 18, Ill., now has available the 1954 Stancor tv transformer replace-


GTC Transformers demanded for Unusual Applications

Du Mont "Multi-Scanners" guarantee finest TV film reproduction . . . a product of the Television Transmitter Division, Allen B. Du Mont Laboratories, Inc.

These GTC Transformers are used in Du Mont "Multi-Scanners"

Du Mont, to maintain leadership in television scanner production and development, specifies only the finest parts — including GTC transformers.

Your products undoubtedly necessitate the use of the finest transformers for standard as well as unusual applications . . . why not specify GTC?

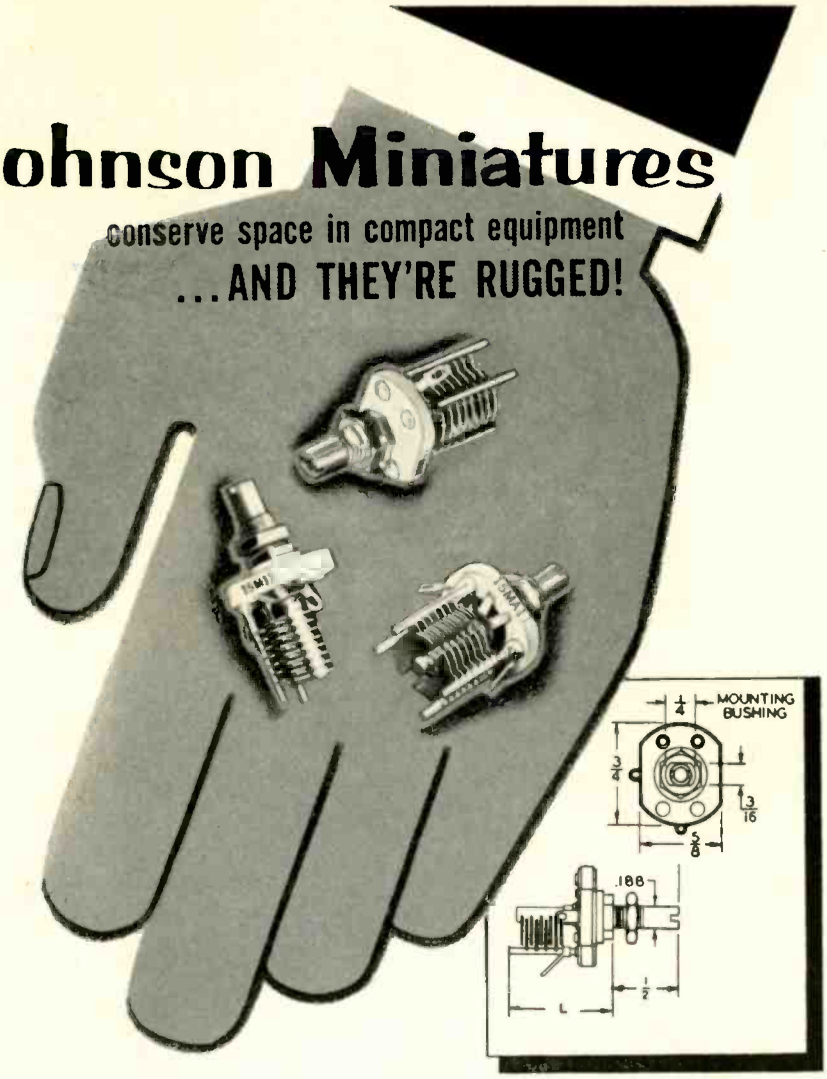
We invite your inquiries

See our exhibit at the Western Electronic Show & Convention August 25-27, Los Angeles

GENERAL TRANSFORMER COMPANY
serving industry since 1928
18240 Harwood Avenue, Homewood, Illinois
(Suburb of Chicago)

GTC

Johnson Miniatures
conserve space in compact equipment
...AND THEY'RE RUGGED!



Requiring a panel area just ⅝" wide by ¾" high (the longest models extend only 1-11/64" behind panel), these miniatures provide the ideal solution to compact design problems. Rugged, Johnson Miniature Air Variables will stand up under the most rigorous conditions, delivering peak performance throughout the VHF ranges. Soldered plate construction, oversize bearings, and heavily anchored stator supports provide extreme rigidity—torque is steady; rotor stays "put" where set. Bridge type stator terminal provides extremely low inductance path to BOTH stator supports. Silver plated rotor contacts for low noise level at high frequencies—all other metal parts nickel plated. DC-200 treated steatite end frames maintain high insulation resistance.

SINGLE SECTION

Cat. No.	Type No.	Cap. per Sec. Max	Cap. per Sec. Min.	Plates per Sec.	L	Net Price
160-102	5M11	5	1.5	5	45/64"	$0.95
160-104	9M11	8.7	1.8	9	13/16"	1.00
160-107	15M11	14.2	2.3	15	1"	1.15
160-110	20M11	19.6	2.7	21	1 11/64"	1.30
160-130	30M8	32	3	28	1 11/64"	1.35

BUTTERFLY

Cat. No.	Type No.	Cap. per Sec. Max.	Cap. per Sec. Min.	Plates per Sec.	L	Net Price
160-203	3MB11	3.1	1.5	5	45/64"	1.35
160-205	5MB11	5.1	1.8	9	13/16"	1.50
160-208	9MB11	8	2.2	15	1"	1.70
160-211	11MB11	10.8	2.7	21	1 11/64"	1.90

DIFFERENTIAL

Cat. No.	Type No.	Cap. per Sec. Max.	Cap. per Sec. Min.	Plates per Sec.	L	Net Price
160-303	6MA11	5.0	1.5	5	23/32"	1.40
160-305	9MA11	8.7	1.8	9	13/16"	1.55
160-308	15MA11	14.2	2.3	15	1"	1.75
160-311	19MA11	19.6	2.7	21	1 11/64"	2.00

SPECIALS—JOHNSON Miniature Air Variables are available in production quantities with the following features: 1. Locking bearing. 2. 180° stop. 3. Various shaft extensions. 4. High torque. We will be happy to furnish quotations on your special requirements. For complete information on standard Johnson components write for your copy of the new Johnson General Products Catalog 975.

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ment guide. Listed in the new reference are transformer replacement data on over 6,800 tv models and chassis of 115 manufacturers, including information on many private label sets. Also included in the guide is a complete catalog listing of 172 Stancor tv replacement components as well as manufacturers' cross reference charts.

Germanium Diodes. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. Catalog data bulletin N-1 describes the type 1N series germanium diodes, giving comprehensive data on standard and replacement types. Included are information on construction, application and dimensions, as well as charts.

Servo Motor Catalog. G-M Laboratories Inc., 4300 N. Knox Ave., Chicago 41, Ill. A new 4-page catalog on a-c servo motors and tachometer generators has been announced. Sizes of servo motors listed range from 0.980 in. to 1.70 in. diameter and are for use on 60 and 400 cycles at voltages from 26 to 115. Applications of units covered range from gun sights and guided missiles through altimeters, direction finders and servo circuits in general. Ask for catalog No. 4.

Precision Potentiometers. DeJur-Amsco Corp., 45-01 Northern Boulevard, Long Island City 1, N. Y. Complete features and specifications for the company's new HP-300 series, 3-in. high resolution potentiometers, are now available in a new 2-page illustrated catalog

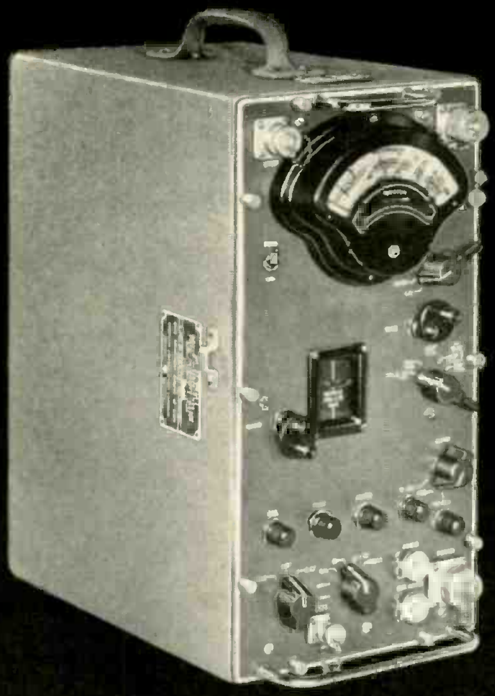
TV Broadcast Products. Allen B. Du Mont Laboratories, Inc., 750 Bloomfield Ave., Clifton, N. J. A new, revised 36-page bulletin lists the complete tv broadcast products manufactured and distributed by the company. Prices of the 480 items listed range from 10 cents per foot of a coaxial cable to $168,-750 for a 50-kw, channel 7-13, transmitter. Products covered by the price list bulletin include: transmitter equipment; r-f load and wattmeters; antennas; frequency monitors; transmission lines; transmitter control units; microwave relays; image orthicon camera chains; Vidicon camera chains; film, slide and opaque equipment; sync generators and pulse distributors; video monitoring equipment; video switcher and mixer equipment; video distribution, patch and power panels, and accessories; racks and consoles; connectors; test equipment; coaxial cables; audio equipment; lighting equipment; and mobile field units.

Sensitive Relays. Hedin Tele-Technical Corp., 640 W. Mt. Pleasant Ave., Livingston, N. J. A recent bulletin outlines the chief features of relay No. 100, one of a line of sensitive relays for electronic and atomic instrumentation, transistors and germanium diodes, telephone and thousands of applications. A dimensional diagram is included.

Close Tolerance Capacitors. Electronic Fabricators, Inc., 682 Broadway, New York 12, N. Y., has available a technical bulletin containing complete information on the EFCON type MH miniature plastic film close tolerance capacitors. Designated Technical Publication 154, the 4-page bulletin is printed in two colors for maximum readability of the data contained which will be of primary interest to design and application engineers. The bulletin contains complete descriptions, specifications, dimensions, test data and characteristic curves.

Electrical Windings and Magnet Coils. Jeffries Transformer Co., subsidiary of Leach Corp., 1710 East 57th St., Los Angeles 58, Calif., has published a comprehensive, 2-color bulletin illustrating typical coils and windings. It covers applications, manufacture, conductivity and resistivity, complete magnet wire characteristics table, tables on temperature coefficient of resistance, reactance, impedance, current, voltage and power factor.

Microwave Tube Catalog. Microwave Associates, Inc., 22 Cummington St., Boston, Mass., announces a new 8-page, 2-color catalog 54T, giving full data on its magnetron, t-r and atr tubes. This brochure is a useful refer-



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Stoddart NM-20B • 150kc to 25mc

Commercial Equivalent of AN/PRM-1A

WIDE FREQUENCY RANGE . . . Covering the most widely used portion of the radio-frequency spectrum, the NM-20B is a precision instrument designed for field or laboratory measurement, analysis and interpretation of all types of radiated and conducted radio-frequency signals and interference. Sturdy dependability, broad frequency range and a full complement of accessories fit this instrument's outstanding characteristics to an impressive variety of applications. Includes standard broadcast band, radio range, WWV, ship-to-shore, amateur and other communication frequencies.

SELF-CONTAINED BATTERIES . . . Battery power allows portable operation of the NM-20B. The ac power supply permits operation from 105 to 125 volts or 210 to 250 volts ac at any frequency between 50 cps and 1600 cps. Its versatile power requirements and special weather-proof construction provide unlimited field operation.

PICKUP DEVICES . . . Pickup devices available for use with the NM-20B include the loop and loop probe, rod antennas and matching impedances for conductive inputs. These permit unlimited usefulness in measuring both conducted and radiated interference.

Stoddart RI-FI* Meters cover the frequency range 14kc to 1000mc

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NM-10A, 14kc to 250kc
Commercial Equivalent of AN/URM-6B. Very low frequencies.

VHF
NM-30A, 20mc to 400mc
Commercial Equivalent of AN/URM-47. Frequency range includes FM and TV bands.

UHF
NM-50A, 375mc to 1000mc
Commercial Equivalent of AN/URM-17. Frequency range includes Citizens band and UHF color TV band.

STODDART AIRCRAFT RADIO Co., Inc.
6644-A Santa Monica Blvd., Hollywood 38, California • Hollywood 4-9294

ence manual for design, standards, production and purchasing personnel in the radar and allied fields.

Null Detection. Industrial Test Equipment Co., 55 E. 11th St., New York 3, N. Y., has available a brochure on the model 100A null meter. It gives applications, principle of operation, features and specifications. Also available is an article entitled "Null Detection of Complex Waveforms." This demonstrates its usefulness for nulling bridges, potentiometers, synchros, resolvers and allied devices.

Titanium Tubing. Superior Tube Co., 1523 Germantown Ave., Norristown, Pa. Properties, applications and advantages of titanium tubing are presented completely in bulletin No. 42. Some of the research and development which went into the product is outlined, together with the properties of titanium which make it a promising material for many new applications. Tube sizes of seamless titanium and Weldrawn titanium are listed. Tubing tolerances, chemical analysis and finishes are other topics discussed. An interesting and informative section is written on processing and fabricating characteristics of titanium tubing.

Electronic Components. Erie Resistor Corp., Erie, Pa. A complete, new 16-page catalog of electronic components for distributors, service departments, laboratories, industrial's, product engineers, and amateurs, has been issued. This catalog, D-54, supersedes previous catalogs and includes the new line of temperature compensating tubular Ceramicons and disk Ceramicons, together with the long-time standard numbers. It is complete with up-to-date listings, illustrations and descriptions.

Recommended Tube Types. General Electric Co., Schenectady 5, N. Y. A 12-page, 3 color booklet (ETR-886) lists recommended receiving and c-r tube types for a-m, f-m, and tv receivers, compiled in tabular form to cover essentially every requirement of the radio and tv manufacturer. Included are characteristics reference charts

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Advancements in the fields of wave propagation, translation of information, communication theory, circuit techniques and equipment miniaturization have created a number of new openings for qualified engineers in the Hughes Advanced Electronics Laboratory.

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Hughes Research and Development Laboratories, located in Southern California, form one of the nation's leading electronics organizations. The personnel are presently engaged in the development and production of advanced electronics systems and devices.

AREAS OF WORK

The communication group is concerned with the design and development of unique radio communication systems and with exploiting new radio communication techniques. People whose interests lie in the fields of propagation phenomena, antenna systems, network theory, magnetic recording, digital techniques, and intricate electromechanical devices are needed in this program.

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How to apply

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CULVER CITY,
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COUNTY,
CALIFORNIA

on the tube types listed and interpretation of technical data.

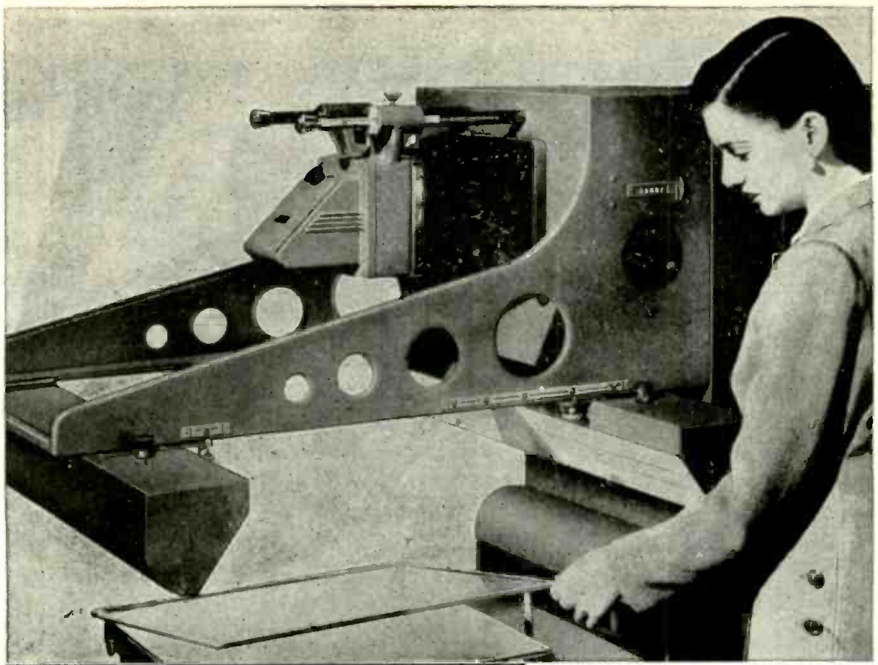
Color Picture Tube Wall Chart. Sylvania Electric Products Inc., Seneca Falls, N. Y., has prepared an educational wall chart showing basic construction and operational features of three types of color tv picture tubes. The chart describes the flat aperture mask, curved aperture mask and field deflection types of color picture tubes. It is particularly timely as a training aid.

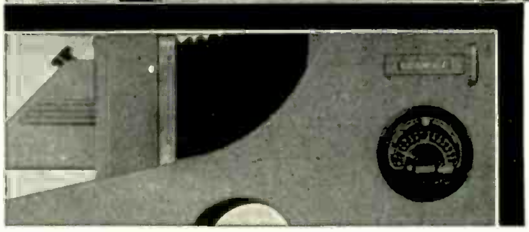
VOR Systems. Collins Radio Co., Cedar Rapids, Iowa. A 12-page brochure deals with the company's low-cost, packaged VOR installation for any field—municipal, commercial or private. Illustrated descriptions are given of the antenna, r-f phase shifter, circuit breaker panel, modulation eliminator, VOR monitor, local control unit and transmitter. Accessory information and specifications are included.

Microwave Tubes and Components. Bomac Laboratories, Inc., Beverly, Mass. A 4-page folder covers gas switching tubes, shutter tubes, hydrogen thyratrons, magnetrons and diodes. Illustrations and technical specifications are included. The company invites inquiries regarding engineering, development and production.

Video Control Equipment. Allen B. DuMont Laboratories, Inc., 1500 Main Ave., Clifton, N. J. Bulletin TR-570 deals with the TA-178-B video switching and mixing equipment. The 4-page bulletin illustrates and describes the type TA-178-B video switching and mixing equipment. Included are features, operation, electrical and physical specifications, power requirements and tube complements.

Electronic Parts. The Electran Mfg. Co., 1901 Clybourn Ave., Chicago 14, Ill. Bulletin No. 530 is a 6-page folder illustrating and describing a line of custom-made transformers, reactors, chokes, special windings and electronic devices. The folder incorporates a helpful check list for anyone considering electrical or electronic components. Twelve guiding ques-





RESET TIMER
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PHOTOCOPYING ON
REMINGTON RAND DEXIGRAPH

An outstanding feature of this versatile photocopying machine is the Cramer Reset Timer, which controls exposures to split-second accuracy and ensures copy prints of absolutely uniform quality. The Type RE Reset Timer is an ideal choice for this application. Its micrometer adjusting dial allows time settings to be changed easily and quickly; yet setting can be made to a high degree of accuracy. A double pointer system is used which indicates not only the time setting but also the time remaining during any particular cycle. The push-button for starting the timing cycle is right on the front of the timer; a flick of the finger controls the machine. The convenient one-hole meter-type mounting also makes for easy assembly in your factory. Note, too, how well the timer blends in with the design of the machine itself.

Remington Rand is only one of the many large equipment manufacturers who look to Cramer when they have a problem in time control. Cramer has a timer for almost any need, ranging from the simplest interval timers up to complex multi-circuit types. Why not consult Cramer for your timing needs?

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Designed and Produced at El Segundo, California
and Westbury, New York

tions are suggested to make a more comprehensive inquiry for a quotation. A brief, interesting note is made of the company's experience in the field.

Selenium Rectifiers. Sarkes Tarzian, Inc., Bloomington, Ind., has published a 72-page selenium rectifier handbook outlining manufacturing processes, characteristics and how-to-use information. It also contains a guide for replacements in radio and tv chassis, along with many circuits and much practical matter.

Germanium Diodes and Transistors. Radio Receptor Co., Inc., 251 W. 19th St., New York 11, N. Y. Bulletin No. G-23 is an 8-page catalog describing a complete line of germanium diodes and germanium transistors. The catalog is fully illustrated with charts voltage curves and diagrams, and lists product applications. Thirty-two different germanium diodes are listed, including 4 JAN types, and 9 hermetically sealed diffused *pnp* junction transistors.

Environmental Chambers and Liquid Chillers. Conrad Inc., Holland, Mich., has issued new data sheets on environmental chambers and liquid chillers. The sheets on the front-opening, and the chest-type, chambers show the interior dimensions and the various combinations of environment available from the company's equipment. The information on the portable laboratory type liquid chillers give the gross Btu capacity per hour for 8 standard models. Specifications of the chambers are also listed.

Duplex Function Plotter. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Data sheet 10.0-17 describes a new ElectroniK recorder for the automatic plotting, on a single chart, of a curve that continuously evaluates two variables in terms of a third. The instrument described incorporates three complete measuring and balancing circuits that can be energized by any d-c millivolt source. Expressed mathematically, the duplex function plotter continuously plots $x, x' = f(y)$. Included in the data sheet are an illustration as well as information on application and operating principle. Specifications are also given.

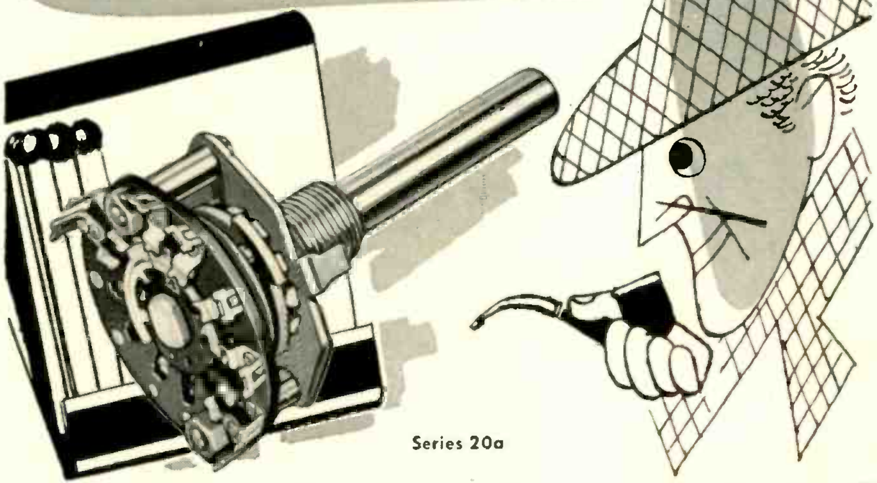
Cross-Guide Coupler. Microwave Development Laboratories, Inc., 220 Grove St., Waltham 54, Mass. Bulletin DC-1 describes the first of a series of directional couplers with a new design concept which permits superior operating performance. Specifications and operating characteristics are given.

Microwave Absorbents. The Sponge Rubber Products Co., Shelton, Conn., has available a bulletin illustrating and describing microwave absorbents for indoor radiation pattern measurements. The absorbers discussed have been used by both government and commercial laboratories to construct anechoic chambers or darkrooms and for screens to shield small areas. Instructions for installation and physical characteristics are given for both the 12-cm and 30-cm types.

Services, Products and Facilities. Allied International Inc., Connecticut & Richards Aves., South Norwalk, Conn. An 8-page catalog describes and illustrates the design-development-production-assembly work done by the company's engineering division for the electronics industry. Product photographs and descriptive text point up Allied's ability to miniaturize entire assemblies, redesign products to meet user specifications, or manufacture to precise tolerances. Besides offering facilities for the production of a variety of electronic and electromechanical devices, the brochure explains, the company also manufactures a number of its own, noncompetitive products. These include complete lines of power supplies, power plants, dry batteries and telecommunications equipment for U. S. and overseas markets.

Pressure Transducer Bulletin. Statham Laboratories, Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif., has available a 12-page bulletin, No. PT-1, describing instruments for the measurement of gage, differential and absolute

If you have to snoop for switch space in chassis . . .


Series 20a

you need Centralab miniatures!

Smaller than a match book, the Centralab miniature switch you're looking at is only 1½" in diameter. It's the biggest space-saving clue to new switch performance in crowded commercial or military low-power, high-frequency electronic equipment ever offered!

- Miniatures available with either steatite or phenolic sections in bolted or staked construction, and in combination with variable resistors and line switches.
- Single and multiple sections — exceptional design adaptability.
- Standard or special combinations — up to 12 positions or up to 6 poles per section.
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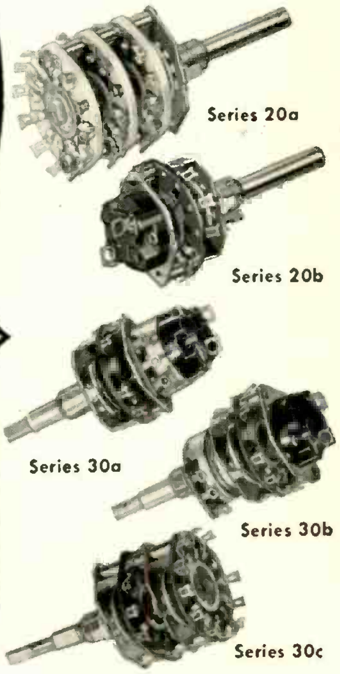
- Indexing 30° or 60° (standard or miniature). 90° (standard only).
- Shorting and non-shorting types.
- Now available—new Series 100 Sub-Miniature for military application only (1⅛" dia.).

Centralab has been solving switch problems for nearly 30 years!



- Centralab switches have been called the prototype of all selector switches in use today.
- Choose from the widest variety available from *any* manufacturer: slide, lever, rotary, power, spring-return, tone, etc. Standard items are available at your local (CRL) distributor — see Catalog 28.

WRITE NOW FOR BULLETINS 42-156 (Series 20), 42-157 (Series 30), EP-SW-1 (Series 100).

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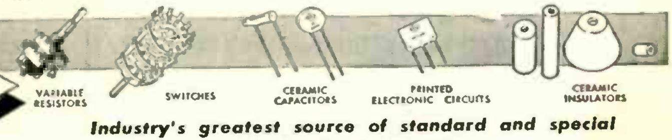

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Engineers and scientists at Sandia Laboratory, an atomic weapons installation, work as a team at the basic task of applying to military uses certain of the fundamental processes developed by nuclear physicists. This task requires applied research as well as straightforward development and production engineering.

The place of an engineer or scientist on the Sandia team is determined initially by his training, experience, and talents . . . and, in a field where ingenuity and resourcefulness are paramount, he is afforded every opportunity for professional growth and improvement.

Sandia engineers and scientists design and develop complex components and systems that must function properly under environmental conditions that are much more severe than those specified for industrial purposes. They design and develop electronic equipment to collect and analyze test data; they build instruments to measure weapons effects. As part of their work, they are engaged in liaison with the best production and design agencies in the country, and consult with many of the best minds in all fields of science.

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pressures. The transducers discussed are based on the principle of the unbonded strain gage which translates pressure into an exact electrical analog output by means of a complete balanced bridge of strain-sensitive resistance wire. The bulletin includes drawings, specifications, and selection tables for eight designs for pressure measurements from 0-0.05 to 0-10,000 psi.

Crystal Catalog. Standard Crystal Co., 1714 Locust, Kansas City, Mo. Catalog 354, a new 12-page illustrated brochure recently issued, incorporates an unusual military chart, designed for customers' guidance in selecting proper crystal types for particular requirements. The catalog features the company's complete line from subminiature, hermetically sealed, plated units to crystal ovens.

Screen-Room Filter Attenuation. Aerovox Corp., New Bedford, Mass., has available a descriptive bulletin giving attenuation characteristics of six different models of standardized and stocked screen-room filters. The bulletin deals with a line of single, double and triple-section filter units developed and produced by the company's subsidiary, Acme Electronics, Inc.

Pulse Transformers. Utah Radio Products Co., Inc., 1123 East Franklin St., Huntington, Ind., has announced a new catalog that lists the electrical and physical characteristics of 33 blocking oscillator, or regenerative driver pulse transformers. The publication will supply the Utah catalog number, pulse voltage, pulse duration, maximum duty ratio, load impedance, rms test voltage, induced voltage and d-c resistance. The catalog lists a few high power pulse and guided missile transformers. Several views of the laboratory list the test facilities available for use on new projects.

Selenium Rectifiers. Fansteel Metallurgical Corp., North Chicago, Ill., recently issued engineering information bulletin 6.400. The 24-page illustrated booklet contains much information useful to the design engineer who uses selenium rectifiers: standard cell sizes and ratings; typical rectifier circuits, formulas and constants; elementary operating principles; typical characteristic curves; typical test circuits; operation of rectifiers at higher than normal temperatures; installation and care; and typical applications with circuit diagrams.

Relay Catalog. Leach Relay Co., Division of Leach Corp., 5915 Avalon Blvd., Los Angeles 3, Calif. A new 44-page, 2-color, loose-leaf catalog illustrates and describes the company's standard relays, and also suggests some of the many modifications that can be made to accommodate special requirements. Details include characteristic, schematics and dimensions. The catalog lists types of relays as follows: midgets, circuit controls, special purpose, radio and high-frequency, aircraft relays and contractors. Also illustrated and described are expanded facilities for engineering, tooling, fabrication, assembly, electrical and environment testing, hermetic sealing and final inspection.

Resistors and Power Rheostats. P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Ind. Form 79-8 is a 27-page catalog for the equipment-design engineer, and devoted to wire-wound fixed and adjustable vitreous-enamel power resistors and power rheostats. It tells the engineer how to specify his power resistor and power rheostat requirements so that quotations and samples can be prepared in the most efficient manner. The catalog contains data about characteristics of available military and commercial designs in the forms of descriptions, line drawings with dimensions, charts, curves and large clear photographs. Also included are hardware, accessories and formulas required in making various resistor calculations.

Laboratory Report. Technology Instrument Corp., 531 Main St., Acton, Mass. Laboratory Report No. 9, now available, features applications of the type 310-A Z-angle meter and the type 320-AB

Amerac's low priced . . .

"S" BAND WAVEMETER

MODEL 131
AMERAC INCORPORATED
WENHAM, MASS.
SENSITIVITY

The model #131 "S" Band Wavemeter (Amerac's version of the popular military model TS-117) covers the frequency range from 2400 MC to 3400 MC in 16 revolutions of the micrometer thimble, by either the transmission or absorption method.

— FEATURES —

- Rugged, cast metal case, attractively finished in gray baked wrinkled enamel.
- Micrometer reading window of magnifying glass makes reading easy.
- Highly sensitive indication of resonance.
- Sensitivity control for setting sensitivity of indicating instrument.
- Rugged components give long, accurate, trouble-free service.
- Precision cavity assembly for accurate repeatable readings.
- Anti-backlash device to give further accuracy.
- Silver-plated parts are Rhodium flashed to minimize corrosion.

PRICE—$325.00

(antenna and fittings available at extra cost)

— SPECIFICATIONS —

Accuracy (at 3260 MC/S).......±½ MC.
(Hand calibrated graphs accurate to ±.02% can be supplied at extra cost)
Loaded Q ....Approximately 1500
Ruggedized 50 microampere indicating instrument.
RF detector........Selected type 1N21-B silicon diode.
Input connections.........2 type N jacks
Output connections (video)......UHF jack
Overall size..6" long, 5½" wide, 3¼" deep
Weight.......................3½ lbs.

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Our experience in unitizing is incorporated in the design below which furnishes 1000 volts DC at 1.5 ma. for a photo-multiplier tube. It is regulated to 0.1% for a line voltage shift of 10 volts. We can build your specifications into just as neat and functional a package, or, as is frequently the case, one of our stock items may meet your requirements.

Uniplugs solve many problems—space, maintenance, spare parts requirements, circuit obsolescence, construction time, etc. They make it especially easy to test experimental designs. They can be hermetically sealed very easily. Some Uniplugs we have built are listed below. They range in size from less than 1. to over 200 cubic inches. Many are stock items.

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Wave Form Generators
DC Filament Supplies
Pulse Generators
Passive Filters
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Lo Impedance Ckts.
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phase meter in school laboratories. Enclosures with this report include several representative experiments conducted at various colleges. These suggest methods of use for certain instruments to simplify common electrical measurements for students.

O-Ring Brochure. Goshen Rubber Co., Inc., Goshen, Ind. A 12-page brochure on O-rings gives detailed information on compounds, groove dimensions and sizes. It contains diagrams of typical applications, and is intended to be helpful to designers and to users of O-ring seals for almost every type of application.

High-Reliability Tubes. General Electric Co., Schenectady 5, N. Y. A 20-page, 3-color booklet (ETD-548C) covers the developmental history of the Five-Star line of high-reliability receiving tubes for critical applications, and design and manufacturing features of the tubes. Also included are technical data and average characteristics on the 22 miniature and 11 subminiature types currently available in the line.

Capacitor Catalog. Astron Corp., 255 Grant Ave., E. Newark, N. J. A comprehensive 48-page capacitor catalog shows latest available types, complete listings and technical data on electrolytic, paper foil and metallized-paper capacitors. The catalog arranges paper-foil and metallized-paper units according to operating temperature and performance characteristics as well as by case types. This makes it easier for the user to determine, select and specify capacitors to meet specific electrical and mechanical requirements. Several new types are shown—plastic encased and sealed paper units with a special patented "blue-point" seal which makes the capacitors completely impervious to moisture, humidity and soldering iron heat. The AC-4 catalog also features one of the most extensive selections of Metalite metallized paper capacitors in subminiature metal and cardboard cases, including a wide variety of high-temperature Hy-Met capacitors for operation at 125 C. Electrolytic units feature Astron "safety margin" construction, and complete listings of miniature metal-can, twist-prong, bathtub and cardboard tubulars for the service trade as well as for original equipment.

Audio Catalog for Broadcasters. Radio Corp. of America, Camden, N. J. A 146-page catalog contains straight-to-the-point information about all the company's audio equipment and accessories designed for broadcast and tv station operations. The book covers more than 200 professional audio items—and includes data, specifications, response curves, typical station equipment lists and studio layouts.

Insulating Varnish. Irvington Varnish Insulator, Division of Minnesota Mining & Mfg. Co., 6 Argyle Terrace, Irvington 11, N. J., has issued a new insulating varnish catalog. A special feature is the section on how-to-use these materials. Included in this section is not only valuable general-use information, but special instructions on the dipping, vacuum, pressure, brush, spray and baking types of application. Another section contains many useful charts such as conversion tables, solvent charts, tank capacities and specific gravity correction tables.

Relay Catalog. Magnecraft Electric Co., 1448 W. Van Buren St., Chicago 7, Ill., recently issued a new relay catalog. It contains complete engineering and dimensional data on long and short form telephone-type relays, new midget subminiature relays, latching and low capacitance relays, open, plug-in, dustproof and hermetically-sealed relays.

Product and Facility Brochure. Servomechanism, Inc., Port & Stewart Aves. Westbury, N. Y. A 12-page illustrated product brochure describes an expanding line of electronic computers and plug-in components. It also provides a brief summary regarding the company's history, design philosophy, general facilities and services available. A concise, yet informative description covers many of the company's latest developments

6385
MADE IN U.S.A.
Bendix

Ruggedized and aged

"RELIABLE" DOUBLE TRIODE

The "Reliable" version of the 2C51 and 5670

Do you have an aircraft or industrial application that requires *utmost* dependability in increasing or controlling alternating voltages or powers . . . in changing electrical energy from one frequency to another . . . or in generating an alternating voltage?

If so, specify the Red Bank RETMA 6385 "Reliable" Double Triode. For it is specially ruggedized to perform at top efficiency longer, even under operating conditions of severe shock and vibration. And, as further assurance of its extra reliability, each RETMA 6385 is factory-aged with a 45-hour run-in under various overload, vibration and shock conditions, such as it might meet on the job.

Whether you need tubes as amplifiers, mixers, or oscillators, it will pay you to investigate the superior, longer-lasting performance qualities of the Bendix Red Bank RETMA 6385.

RATINGS*

Heater voltage—(AC or DC)**	6.3 volts
Heater current	0.50 amps.
Plate voltage—(max.)	360 volts
Max. peak plate current (per plate)	25 ma.
Max. plate dissipation (per plate)	1.5 watts
Max. peak grid voltage	+ 0 volts −100 volts
Max. heater-cathode voltage	300 volts
Max. grid resistance	1.0 megohm
Warm-up time	45 sec.

(Plate and heater voltage may be applied simultaneously.)

*To obtain greatest life expectancy from tube, avoid designs where the tube is subject to all maximum ratings simultaneously.

**Voltage should not fluctuate more than ±5%.

PHYSICAL CHARACTERISTICS

Base	Miniature button 9-pin
Bulb	T-6½
Max. over-all length	2³⁄₁₆ in.
Max. seated height	1¹⁵⁄₁₆ in.
Max. diameter	⅞ in.
Mounting position	Any
Max. bulb temp.	160° C

AVERAGE ELECTRICAL CHARACTERISTICS

Heater voltage, E_f	6.3 volts
Heater current, I_f	0.50 amps.
Plate voltage, E_b	150 volts
Grid voltage, E_c	−2.0 volts
Plate current, I_b	8.0 ma.
Mutual conductance, g_m	5000 μmhos
Amplification factor, μ	35
Cut-off voltage	−10 volts
Direct interelectrode capacitances (no shield)	
Plate-grid (per section)	1.7 μμf
Plate-cathode (per section)	1.1 μμf
Grid-cathode (per section)	2.4 μμf
Plate-plate	0.1 μμf

Bendix Red Bank

Manufacturers of Special-Purpose Electron Tubes, Inverters, Dynamotors and Fractional HP D.C. Motors

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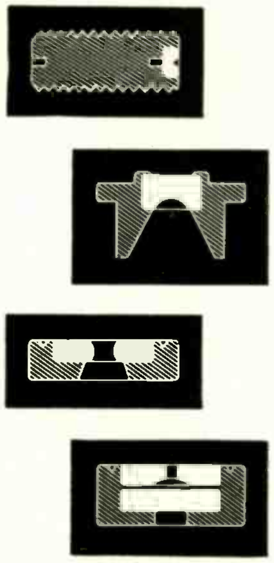
Bird COMPLETE JEWEL ASSEMBLIES WILL SPEED YOUR PRODUCTION



You'll be time and money ahead if you specify Bird complete jewel assemblies for your product. Rejects are eliminated, jewel breakage is minimized, and Bird jewel assemblies will keep your production running smoothly.

Bird Jewel Assemblies are furnished in the right mounting, rigidly inspected according to your specifications, ready for your assembly operations. Make a test — find out how Bird Jewel Assemblies can help your production. Send us a print of your specifications, and we'll provide samples for your own testing.

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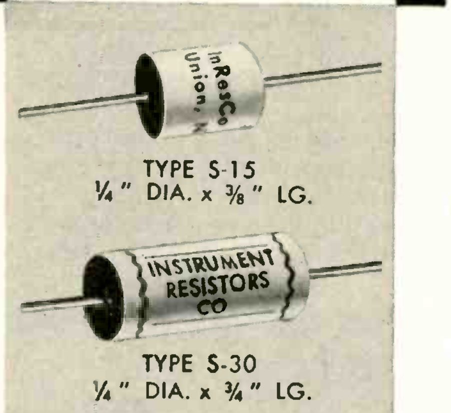
THE ECONOMICAL SOLUTION where moisture proof resistive elements of comparatively small size are required for commercial applications. Type S-15 is 3/8" long by 1/4" diameter; type S-30 measures 3/4" by 1/4" diameter. Both types are moisture proof and capable of high performance over long periods of continuous service. IN-RES-CO Resistors for every ordnance or civilian requirement are available at a cost that solves circuit design problems both performance-wise and cost-wise. Check up now, on the complete line of IN-RES-CO quality wire wound resistors.



TYPE S-15
1/4" DIA. x 3/8" LG.

TYPE S-30
1/4" DIA. x 3/4" LG.

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INSTRUMENT COMPANY

APPLICATION-DESIGNED RESISTORS FOR ELECTRONICS AND INSTRUMENTATION

such as mach computers, master air data computers, accelerometers and positioning mechanisms.

Germanium Crystals. Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y., has published a 42-page booklet entitled "Industrial Uses for Germanium Crystals." Each application offered introduces the germanium crystal to the most exacting of users. The four main chapters in the booklet cover: relays and relay applications; timing circuits; power supply applications; and applications to industrial instrumentation.

Printed Circuits. Photocircuits Corp., Glen Cove, N. Y. Printed circuits, their function, fabrication and application are comprehensively outlined and described in a new 8-page brochure. The brochure includes information on methods of application, materials, electrical characteristics, components such as capacitors, resistors, tube sockets, switches and transformers. Assembly with dip soldering and plated-through holes is described. Design improvement and lower production costs are amply suggested in this engineering brochure.

Electrical Indicating Instruments. The Hickok Electrical Instrument Co., 10527 Dupont Ave., Cleveland 8, Ohio, has announced a 48-page catalog of electrical indicating instruments, laboratory portables and panel meters of finer accuracy. It provides illustrations and specifications of the more popular sizes of round, square, flush, semiflush, switchboard, horizontal edgewise and fan type meters as well as 250-deg arc-angle sealed and ruggedized types presently available. Typical listings are ammeters, decibel meters, frequency meters, microammeters, milliammeters, millivoltmeters, voltmeters, wattmeters, shunts, transformers and special developments.

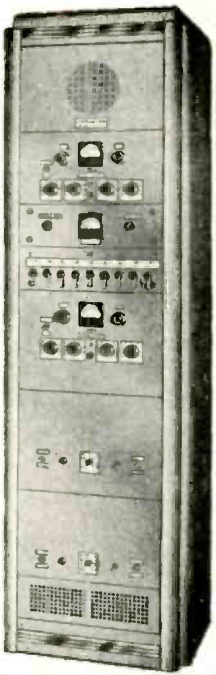
Resistors and Power Rheostats. Tru-Ohm Products, 2800 N. Milwaukee Ave., Chicago 18, Ill. A 20-page catalog features the complete line of the company's resistors and power rheostats. Standard and special size resistors are illustrated as are resistor mountings. A section of the catalog is devoted to power rheostats—25, 50, 75, 100 and 150 watts. Information also includes data on special rheostat shaft and bushing assemblies, taper wound rheostats and tandem rheostat assemblies. The Tru-Ohm ceramic welding nozzles are also included.

Decade Pulse Capacitor. Aircraft-Marine Products, Inc., 155 Park St., Elizabethtown, Pa. Catalog sheet No. 831357 illustrates and describes the Capitron 8-kv decade pulse capacitor. Included are a schematic, characteristics and specifications and price.

Decade Shunt. Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio, has published a single-sheet bulletin covering the model 2008 decade shunt, an accessory that clips easily over the input terminals of an electrometer, quickly converting it to a wide-range micromicroammeter. Besides an illustrated description of the unit, the bulletin contains specifications, typical uses and ordering suggestion.

F-M Ring Antenna. Collins Radio Co., Cedar Rapids, Iowa. A six-page folder illustrates and describes the 37M series f-m ring antennas that consist of only two basic parts: (1) radiating rings and (2) connecting inter-ring transmission line. It points out such features as ease of installation, mechanical stability, high gain, low vswr and power capacity. A page of engineering data contains complete mounting information.

Improved Lighthouse Tube. General Electric Co., Schenectady 5, N. Y. An 8-page, 3-color booklet (ETD-881) describes the new GL-2C39-B metal-and-ceramic Lighthouse tube, an improved version of the metal-and-glass GL-2C39-A. The new high-mu triode discussed is designed for use in vhf-uhf circuits as a grounded-grid class-C power amplifier, oscillator, or frequency-multiplier, at frequencies up to 2,500 mc. Technical data and typical operating conditions are included.



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SERIES 6918 or 6924
RACKS
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18½" or 24" DEEP, for 19" WIDE PANELS

- Panel Spaces: 61¼", 70", or 77" high.
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- Series 6918 or 6924 Racks may be used in "rows" or "gangs," as corner trims are removable from front of cabinet.
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THESE RACKS ARE MODERATELY PRICED and AVAILABLE FOR SHIPMENT FROM STOCK

Our P-6924 Rack as used by Gai-Tronics, Inc., Reading, Pa.

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SOLDERING IRONS

Solder Faster with Lower Tip Cost!

For example, Cat. P-214 has more speed than conventional 200 watt iron, but takes ¼" tip instead of ⅝" *(only 1/6th the copper).*

SIX MODELS TO CHOOSE FROM

Tip Dia.	Watts	Cat No.	List Price
1/4	100	P-114	$8.25
1/4	150	P-154	9.00
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1/2	200	P-212	10.00
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Write for Catalog showing 40 industrial soldering irons of every type and size; no obligation.

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PLANTS AND PEOPLE

Edited by WILLIAM G. ARNOLD

Engineers attend industry meetings and symposiums . . . Associations name new officers and honor industry leaders . . . Manufacturers plan plant expansions, promote engineers . . .

OTHER DEPARTMENTS featured in this issue:

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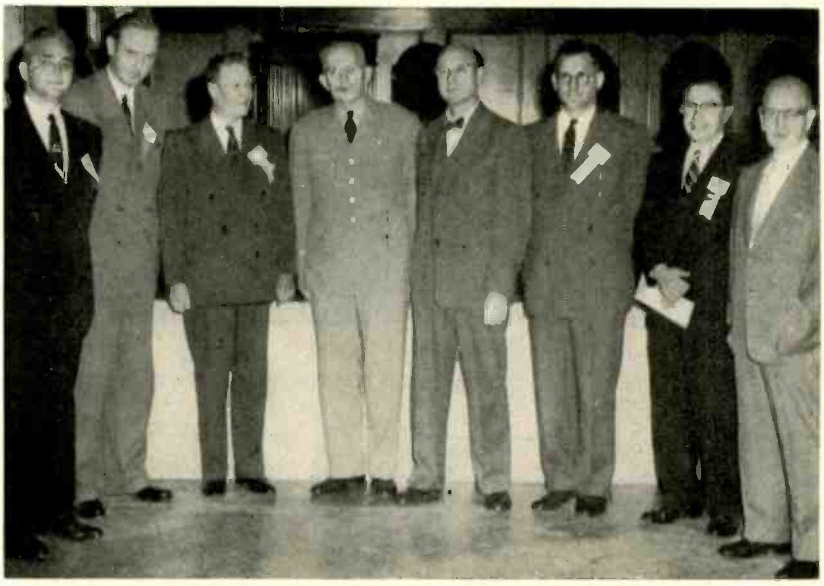
Electronic Components Symposium Draws Top Engineers

BETWEEN 800 and 1,000 electronic engineers and scientists assembled in Washington for the fifth of a series of national meetings on electronic component parts and materials.

The theme of the 1954 Electronic Components Symposium was "Technical Progress in Component Development, Fabrication and Use, With Emphasis on New Advances in the Art." The meetings were sponsored jointly by the AIEE, IRE, RETMA, WCEMA, with participation by agencies of the Department of Defense and NBS.



Leaders of industry and government who spoke during the opening session of the symposium on the topic "The Executive Views Components" were, left to right: M. Barry Carlton of the Department of Defense, chairman of the symposium committee; R. S. H. Hylkema of Philips Industries, Eindhoven, Holland; Robert C. Sprague of Sprague Electric and chairman of the RETMA board of directors; Brig. Gen. W. Preston Corderman, Chief of the Signal Corps Engineering and Technical Division; D. E. Noble of Motorola; C. H. Elmendorf of Bell Telephone Laboratories; A. W. Rogers of Signal Corps Engineering Laboratories and W. H. Martin, Deputy Assistant Secretary of Defense (Applications Engineering).

Armed Forces Communications Group Elects Bailey President

GEORGE W. BAILEY, executive secretary of the IRE, was elected president of the Armed Forces Communications Association for the one year term.

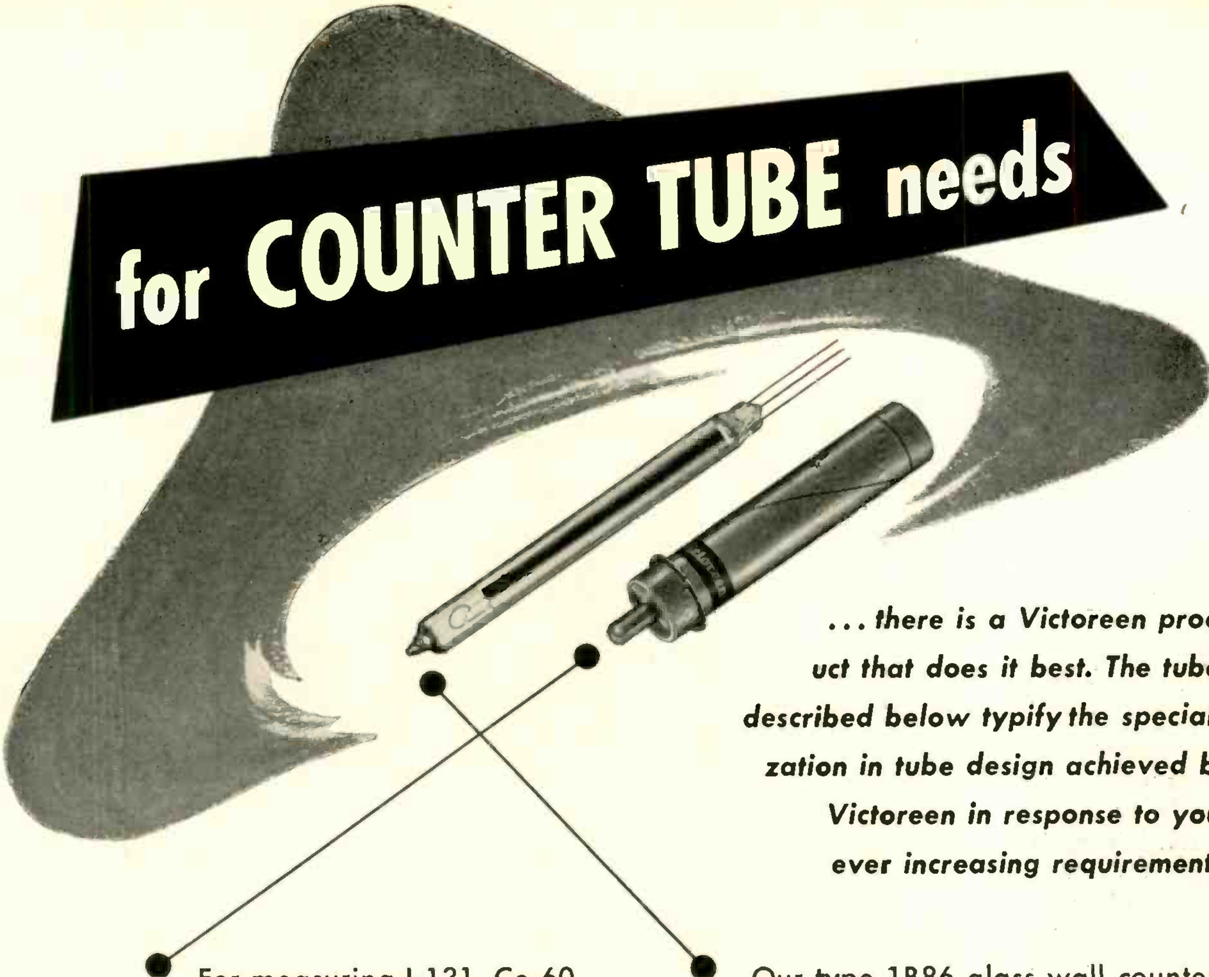
During World War II, he served in Washington, D. C. as Chief of the Office of Scientific Personnel under Dr. Vannevar Bush, Director of the Office of Scientific Research and Development. He received the Certificate of Merit from President Truman for his work there.

Bailey was appointed executive secretary of the Institute of Radio Engineers in 1945 and heads the national headquarters office of the society in New York City.

From 1940 to 1952 he held the offices of president of the American Radio Relay League and president of the International Amateur Radio Union.

The following men were elected vice-presidents of AFCA: Major General G. A. Blake, Chief of Air Force Communications; Major General G. I. Back, Chief Signal Officer;

for COUNTER TUBE needs



... there is a Victoreen product that does it best. The tubes described below typify the specialization in tube design achieved by Victoreen in response to your ever increasing requirements.

For measuring I-131, Co-60, and Ra we offer the type 6306 bismuth-coated cathode counter tube. It is six times as efficient on gamma radiation from I-131 as regular counter tubes, and from two to five times as efficient on Co-60 and Ra. The 6306 has an aluminum wall and coaxial type base for quick mounting.

For all around general use our type 1B85 is recommended. It is a beta-gamma sensitive tube. High uniformity from tube to tube of the 1B85s simplifies instrumentation since a fixed-voltage power supply is adequate for their operation. Such uniformity eliminates the need for individual voltage compensation. This aluminum wall tube may be used interchangeably with the 6306 tube.

Our type 1B86 glass wall counter is a gamma sensitive tube which operates at one-third the voltage required by most counters. This means fewer batteries. It is an ideal detector for compact, light-weight applications at lowest cost.

Type VG-18 is a halogen-filled counter tube in a glass envelope with tinned leads. This tube can be used in ordinary counting circuits or as an integrating tube. This tube is widely used where good performance is necessary and low cost is the prime factor.

Victoreen's rigid standards and ample production facilities assure GM type counter tubes of the highest quality at very low cost. Your inquiries are invited

The Victoreen Instrument Co.

COMPONENTS DIVISION: 3800 PERKINS AVE. • CLEVELAND 14, OHIO

Rear Admiral W. B. Ammon, Chief of Naval Communications; W. W. Watts, vice-president of RCA and Rear Admiral E. W. Stone, president of American Cable and Radio.

Medal of Honor Goes To Robert C. Sprague

ROBERT C. SPRAGUE, chairman of the Radio-Electronics-Television Manufacturers Association's board of directors, has been chosen to receive the "Medal of Honor" for his outstanding contributions to the radio-electronics and television industry during the RETMA annual convention in Chicago.

He has been a director of RETMA since 1943 and was chairman of the Association's Parts Division for two terms, 1944–45 and 1945–46. Subsequent to his Parts Division chairmanship, he served as head of the RETMA "Town Meetings" committee which directed activities in the interests of radio and television dealers and service technicians.

He was a member of the War Production Board Advisory Committee on electric condensers, 1942-45; chairman of the Office of Price Administration Industry Advisory Committee for the radio parts industry, 1944; and a member of the Massachusetts Committee on Post-War Reconversion, 1942.

The award was established in 1952 to provide industry recognition of outstanding contributions to the advancement of the industry.

Computing Group Elects Officers

SIBYL M. ROCK of ElectroData Corp. was elected chairman of the Southern California chapter of the Association for Computing Machinery at the first meeting of the newly organized group recently held in Los Angeles.

Other officers named to guide activities of the unit of national ACM, which was founded in 1949 to foster exchange of information in the analog and digital computing fields, include: Irving Lieberman of Hughes Aircraft, secretary and Paul Armer of Rand Corp., treasurer.

TV Sets Makers See Du Mont Color Tube

ATTENDING a demonstration of Du Mont's 19-inch color television picture tube at the firm's research laboratories are, left to right: Robert Capadano, vice-president of engineering of Emerson Radio; H. Leslie Hoffman, president of Hoffman Radio; Allen B. Du Mont, president of Du Mont Laboratories; Dorman Israel, vice-president of Emerson Radio; Frank O'Brien, vice-president of purchasing for Motorola and Harvey Tullo, v-p of purchasing for Emerson.

GE Expands For Military Electronics

TWO NEW buildings now under construction in Syracuse, N. Y. Industrial Park development are to be leased by GE's heavy military electronic equipment department. The structures will provide 100,000 sq ft of floor space and allow for consolidation of some of the department's shop and office facilities. They will be ready for occupancy this fall.

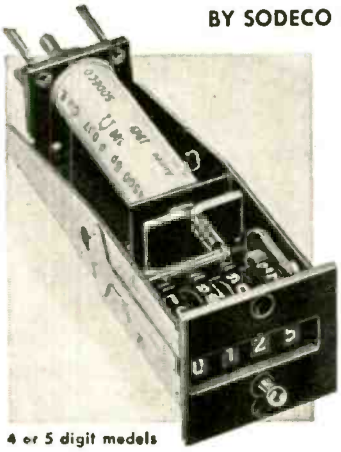
Indication of plant and equipment facilities needed for the production of military electronic equipment is seen in GE's light military electronics plant in Utica, N. Y., shown above.

The plant has been in operation

— the Counter —

YOU'VE BEEN WAITING FOR!

BY SODECO GENÈVE



4 or 5 digit models

INSTANTANEOUS RESET... to zero. Single-stroke lever action.

COMPACT... flush-mounting plate measures only 1-5/16" x 1-3/16".

FAST... standard models count up to 10 Impulses/sec. (Special models available with speeds up to 25 impulses/sec.).

TELLS AT A GLANCE... when coil is energized. Half numbers indicate this condition.

ACCURATE • DEPENDABLE • FLUSH MOUNTING

Write for Bulletin 22

LANDIS & GYR, INC.

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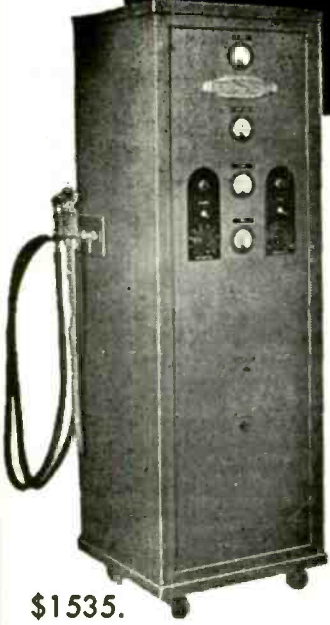
for maximum economy... 5KW VACUUM TUBE BOMBARDER OR INDUCTION HEATING UNIT



$1535.

Simple... Easy to Operate... Economical Standardization of Unit Makes This New Low Price Possible.

Maximum economies can be obtained only by use of correct frequency and power combinations when applying the techniques of induction heating to manufacturing processes.

It is significant that only Scientific Electric in the present market, can offer you a selection of frequencies depending on power required, in wide power range. 2-3½-5-6-7½-10-12½-15-18-25-40-60 KW (all units above 60 KW are considered custom built). This means that electronic heating equipment produced by Scientific Electric is tailored to your needs... fitted perfectly to the task entrusted to it, enabling you to keep your initial investment in equipment to a minimum while affording you all the proven advantages of electronic heating.

Write now for complete information or send samples of work to be processed. Specify time cycle for your particular job. We will quote on proper size unit for your requirements.

DESIGNERS AND MANUFACTURERS OF HIGH FREQUENCY AND HIGH VOLTAGE EQUIPMENT SINCE 1921

Scientific Electric

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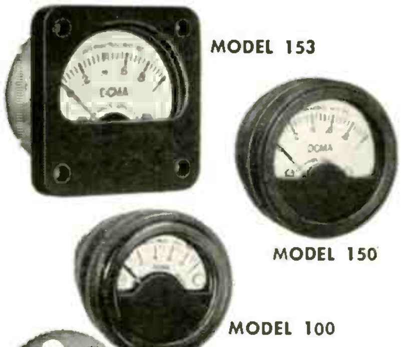
miniaturization

. . . because *miniaturization* meets today's demands for increased performance from smaller, lighter equipment. It saves vital space and weight on aircraft, guided missile and many similar applications . . . and it is bringing new portability and usability to countless types of commercial and industrial equipment.

If your miniaturization problem involves instrumentation, we can help. International Instruments is devoted exclusively to the design, development and production of miniature instruments and has created many important "firsts". We offer a complete line of 1" and 1½" Meters featuring accuracy and dependability comparable to conventional sized meters . . . plus far greater resistance to shock and vibration. Special scales and ranges can be provided to meet practically any electrical measuring requirement. Use the coupon below to send for data sheets covering our standard instruments — or ask our Engineering Department to help with your special needs.



international instruments
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☐ Please send data sheets covering your standard instruments.
☐ Arrange to have your representative call.

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POSITION__________
COMPANY__________
CO. ADDRESS__________
CITY__________
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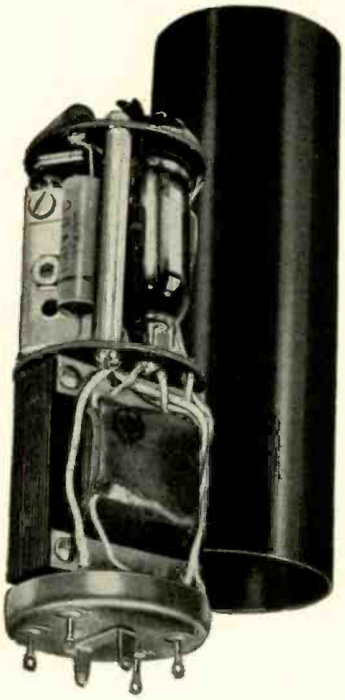
James is *the* complete source for all vibratory products!*
THE ENGINEER'S STANDARD SINCE 1936
*Send your engineering problems to us



JAMES MODEL C-867
INPUT 6.3 VOLTS
OUTPUT 750 VOLTS D.C.

This Vibrator Power Supply is designed and manufactured to customer specifications by JAMES.
Similar assemblies for extreme limits of vibration, shock, temperature and reliability are now possible through the use of JAMES components...and JAMES' facilities for product design and engineering are at your disposal.
We invite your inquiries to our Engineering Department for their recommendations and quotations.

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4038 N. Rockwell St. • Chicago 18, Ill.

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for approximately eight months on the design, development and production of military radar and electronic equipment.

The building has a single-story factory section, 842′ long and 352′ wide; and a two-story office and laboratory section 632′ long and 75′ wide.

Space on the first floor of the office-laboratory section is devoted to executive and administrative offices, cafeteria, dispensary and personnel offices.

The second floor is devoted to engineering and research laboratories and offices, drafting rooms, photoreproduction facilities and an engineering conference room.

Of the total 372,000 sq ft of floor space in the factory section shown on p 304, approximately 250,000 sq ft of space is used in manufacturing which is essentially a bench assembly of component parts.

Automation

An automatic and remotely controlled conveyor system is used to transport components to and from the assembly-bench area. Spanning the factory among the structural members, the system includes some two dozen sections, each section having its own drive motor. Tie-ups at intersection points of the system are prevented by photo-cell controls, activated by material on the conveyors, to halt the drive motors temporarily through electronic relays.

Parts from the main conveyor are shunted to various branch lines in the stockroom area by solenoid-controlled deflectors. Deflector selection is determined by a steel ball placed in various holes in the conveyor basket bottom, the ball making contact with a particular deflector switch. Packages are stopped by limit switches.

The production assembly areas have their own test facilities. They consist of eighteen 11′ x 13′ cubicles mounted on platforms secured to building columns approximately 8 feet above the production floor level.

Feature of the plant is the distribution network for the supply of electrical power for research and development testing and production testing which cost $1.5 million.

Climatic test equipment in the

plant includes two climate chambers with a free inside volume of 12 x 8 x 9 feet; and four of 6 x 8 x 7½ feet. Temperature range from −85 deg. F to 248 deg. F; and relative humidity from 39% to 95%. Pressure can be reduced to simulate an altitude of up to 100,000 feet. There are additional chambers for temperature and humidity tests only and for special heat tests.

Physical stress test facilities include a water immersion pit, six feet square and 18 feet deep; a medium-impact sand shock machine which, by dropping a 1200-lb load for 36-in. provides the equivalent of a 70-G maximum deceleration; a tilt-test machine which inclines 45 degrees to each side of level with variable frequency, simulating a ship's roll; and a hammer shock test machine, with a 400-lb hammer and 5-foot swing span.

Vibration testing equipment is provided. It includes three small and one large mercury reaction vibrators and two other testers.

WESCON Program Events Take Form

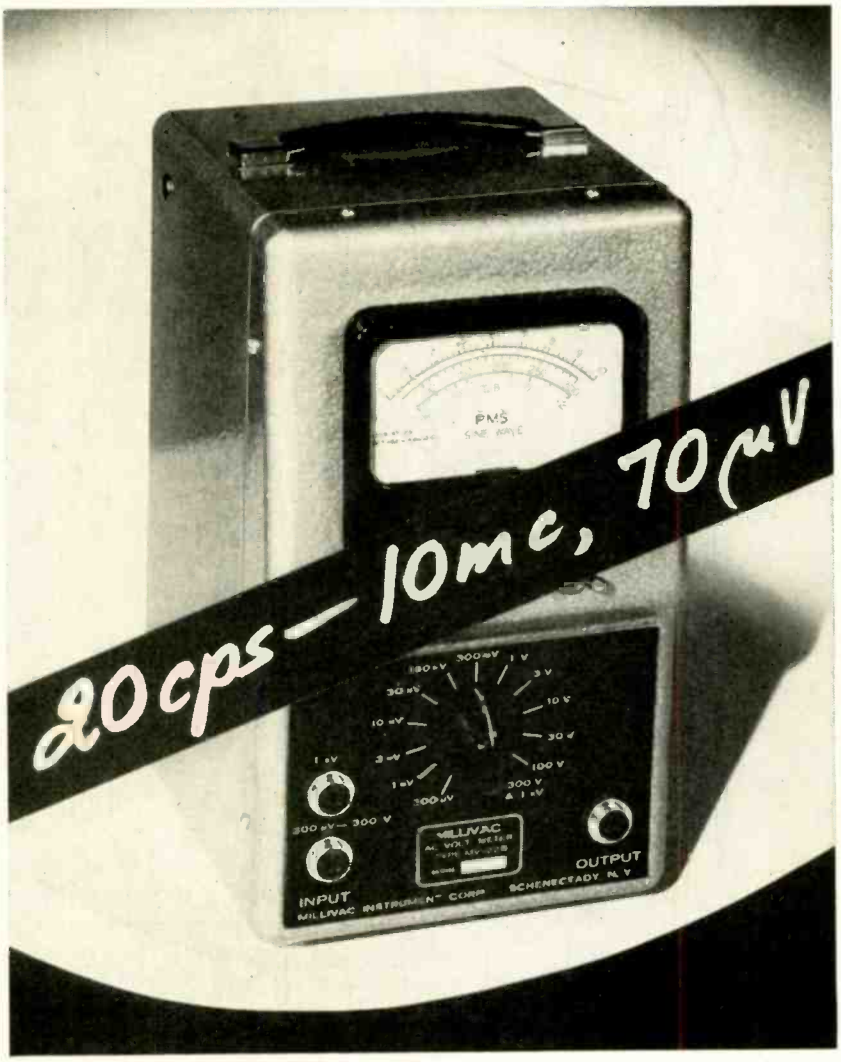
PLANS ARE moving ahead for the 1954 WESCON (Western Electronic Show and Convention) to be held on Aug. 25-27 in Los Angeles' Pan-Pacific Auditorium and Ambassador Hotel.

WESCON will be sponsored jointly by WCEMA (West Coast Electronic Manufacturers' Association and the Los Angeles and San Francisco sections of I.R.E.

According to W. D. Hershberger, chairman of the WESCON board of directors, this year's show and con-

W. D. Hershberger

NEW "ULTRA-VIDEO" VOLTMETER



The new Millivac MV-22 B Vacuum Tube Voltmeter with its 20 cps to 10 mc frequency range, fills a long-felt need for a sensitive VTVM which should cover the video frequency range with sufficient expansion into the "ultra-video" frequency range. This range is beyond 4.5 mc and must be covered by VTVM-s to make possible fully responsible gain measurements of camera-amplifiers, monitor amplifiers and modulation amplifiers, and, their pulse characteristics.

Our customers have repeatedly pointed out to us that wide band amplifier research in the television field requires sensitive vacuum tube voltmeters which go beyond such limits as 2 mc, 4 mc, or 6 mc as found in earlier models made by us and others. 10 mc is considered the very minimum of frequency response required. Sufficient sensitivity is another requirement to make gain measurements possible at true operating voltage levels. Measurements at substantially raised levels (to make up for lack of voltmeter sensitivity) result in major errors, because non-linearity of high-Gm amplifiers, due to varying plate resistance with signal level, can create gain measurement errors at certain frequencies of up to 50% or even more. Sweep signal displays on insufficiently sensitive scopes can create equally serious errors.

The MV-22 B, for the first time, sets at the disposal of development and production engineers, a high impedance voltmeter, sufficiently sensitive and endowed with a sufficiently wide frequency response, to make *accurate* measurements of gains possible at *true* operating voltage levels, microvolts where microvolts normally occur, millivolts where millivolts, and volts where volts are normally found.

We consider the unprecedented performance of this fine, new instrument our most important contribution to the electronic field since we first introduced Millivac meters. Its final perfection completes nearly 3 years of intensive research.

SPECIFICATIONS:

Voltage: 70 uV-1KV in 14 ranges, 10 DB steps
Frequency: 20 cps-10 mc up to 300 V, 20 cps-1 KC on 1 KV range.

Accuracy: 3½% full scale, through entire frequency range.

Input: 1 Meg, 20 MMF without, 10 Meg, 6 MMF with 10:1 divider probe

TIME PROGRESSES—SO DO WE

MILLIVAC INSTRUMENT CORPORATION

P.O. BOX 997 *SCHENECTADY, NEW YORK*

Write to us directly for more Information

Designed for Application

VERT
HOR.
90901

The No. 90901
One Inch
Instrumentation Oscilloscope

Miniaturized, packaged panel mounting cathode ray oscilloscope designed for use in instrumentation in place of the conventional "pointer type" moving coil meters uses the 1" 1CP1 tube. Panel bezel matches in size and type the standard 2" square meters. Magnitude, phase displacement, wave shape, etc. are constantly visible on scope screen.

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MFG. CO., INC.

MAIN OFFICE AND FACTORY
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Thomas P. Walker

vention is expected to surpass all previous western records in both attendance and exhibitor participation.

More than 500 exhibit booths have been reserved compared to a total of 370 occupied in last year's show.

According to Thomas P. Walker, WESCON vice-chairman representing WCEMA, it has been necessary to add an 11,000 square foot annex to the Pan-Pacific Auditorium in order to accommodate exhibitors desiring space.

Nearly 20,000 people are expected to attend the three-day conclave.

Work has been underway on the convention since the first of the year under the leadership of C. F. Wolcott, vice-chairman representing IRE.

Twenty-eight technical sessions are on the program. Tentative plans call for sessions on audio, antennas and propagation, circuit theory, vehicular communications, broadcast and TV, telemetering, airborne electronics, information theory, management, electron devices, computers, microwave theory, and component parts.

Sessions and panels are arranged in a general schedule of ten sessions per day with additional sessions of special interest in the evenings. More than 100 technical papers will be presented in all.

Several special events will also be held. At the annual all-industry luncheon on Aug. 27 the featured speaker will be William R. Hewlett, national president of I. R. E.

WCEMA Scholarship Awards will

BE ON THE
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Florida wants and needs electronics industries of special types. Florida offers what you need.

Manufacturers of tubes, resistors, coils, expensive transformers, light weight electro-mechanical components and specialized instruments and equipment will find Florida an ideal location.

Manpower of all types and skills is plentiful—and more than 1,965 new residents are moving to Florida every week. The labor climate is excellent.

Plant construction, maintenance and heating costs are lower in Florida because of the mild year-round climate.

Taxes are favorable, too. Florida has no State income tax, no State inheritance tax, no State ad valorem tax.

Florida's importance in Air Force, Army and Navy electronics programs is widely known and proximity to the big Florida operational and experimental bases could be valuable to you. So could its strategic relationship to Southern and Latin-American markets.

A few electronics research and development companies are already established in Florida. There's still room for more such companies on the ground floor.

For dependable information write: Industrial Development Division, State of Florida, 3306F Caldwell Building, Tallahassee, Florida.

you'll always
do better in
Florida

C. Frederick Wolcott

be presented at this time to outstanding students of accredited western engineering universities, and the 7th Region I. R. E. annual Achievement Award will be presented to the I. R. E. member in the Pacific Region adjudged to have contributed the most to electronics in the West during the past year.

Magnecord Names Witte And Boylan

MAGNECORD has appointed Roy Witte as chief mechanical engineer and William F. Boylan as chief electronic engineer.

Witte joined Magnecord in 1953, as a project engineer. Previously he was with Hallicrafters as chief mechanical engineer and spent seven years with Motorola as assistant engineering service manager.

Boylan joined Magnecord in 1950 as an electrical engineer, later becoming senior electrical engineer on commercial production. He previously served as an instructor of electronics and mathematics at the DeForest Training School in Chicago.

RETMA Charts Actions, Adds New Members

AT THE 11TH JOINT conference of RETMA and the Radio-Television Manufacturers Association of Canada, steps were taken to increase the Association's revenue by voluntary contributions, to implement its program for industry self-regulation of TV interference, and to set up policy committees which will direct activities with respect to the radio-TV excise tax and UHF television.

Robert S. Gates, executive vice-

Space Temperature ?

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- Type T. B. - Ceramic Case
- Type T 70 - (CP 70 Can)

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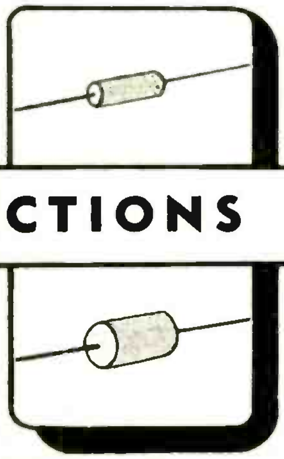
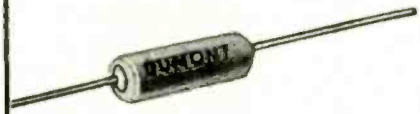
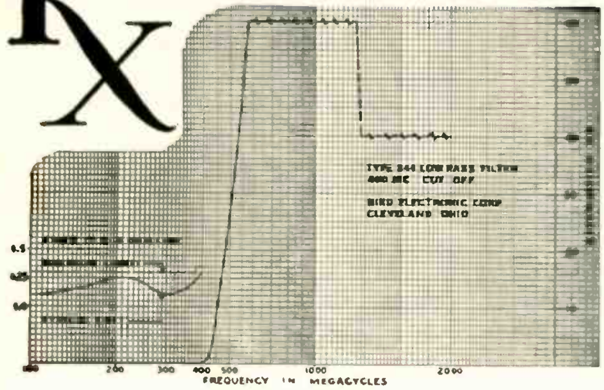
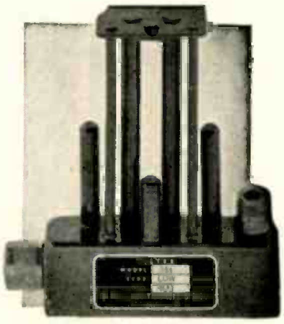




T 70
.5 MFD.
2000 WVDC
DUMONT

R for HARMONIC TROUBLES





Model 844
Low Pass Filter

• Suppression of low-order harmonics in transmitters operating below 400 mc is the prime function of Model 844 Low Pass Filter. 40 db or more attenuation of 2nd to 5th harmonics of transmitters operating between 225-400 mc is afforded. Insertion loss and VSWR are very low thruout the pass band. Teflon insulation and rugged construction thruout assures reliability.

FREQUENCY RANGE — pass band 0-400 mc. Stop band 500-2000 mc.
POWER RANGE — 150 watts maximum.
IMPEDANCE — 50 ohms. VSWR better than 1.35 thru pass band.
CONNECTORS — Type N. One male and one female. Filter is reversible with equal results.
ATTENUATION — pass band-.3db or less below 400 mc. Stop band-40db or more 500 to 2000 mc.
PHYSICAL DIMENSIONS — 5⅛" H x 5" W x 1". Weight — 12 oz.

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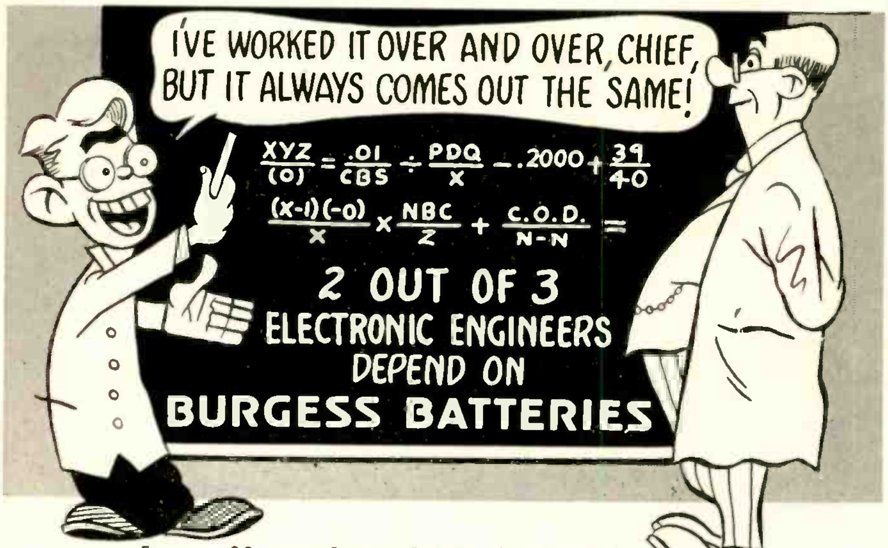
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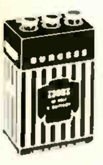
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president of Collins Radio, was elected a director-at-large.

After hearing a report by W. R. G. Baker, chairman of the Special Committee on Spurious Radiation, on the response of set manufacturers to a RETMA proposal for voluntary submission of tv and f-m receivers to an independent testing laboratory for measurement of radiation characteristics, the engineering department was authorized to select a testing laboratory and establish operating procedures as promptly as possible.

Dr. Baker was authorized to report to the FCC the names of all set manufacturers who agree to adhere to RETMA radiation limitations and the RETMA intermediate frequency engineering standard and who will submit sample receivers to the testing laboratory for certification.

Appointment of a Tax Policy Committee was authorized. This committee will have authority to plan a long-range program designed to persuade Congress that the excise tax should be repealed.

Ultrahigh Frequency

Creation of a uhf Policy Committee also was authorized.

The UHF problem was discussed by members of the Set Division Executive Committee and the Radio-Television Industry Committee which recommended the creation of both the uhf Policy Committee and the Tax Policy Committee.

RETMA membership reached a new high of 383 with the following 17 new members:

ACF Electronics (Division of American Car and Foundry Co.), Alexandria, Va.; Boeing Airplane Co., Seattle 14, Wash.; Calvideo Tube Corp., Los Angeles 45, Calif.; Cargo Packers, Inc., Brooklyn 11, N. Y.; Collins Radio Co., Cedar Rapids, Iowa; Condenser Manufacturers, Inc., Nashville 4, Tenn.; Connector Corp., Chicago 30, Ill.; Consolidated Vultee Aircraft Corp., Pomona Division, Pomona, Calif.; Elcon Electronics Inc., Brooklyn 32, N. Y.; Elgin Metalformers Corp., Elgin, Ill.; Hy-Gain Television Products, Lincoln, Neb.; International Telemeter Corp., Los Angeles 25, Calif.; Maurice I. Parisier & Co., New York 36, N. Y.; Southern Electronics Co., Greeneville, Tenn.;

versatile

Multi-channel --
telegraph Al or
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FROM GROUND TO AIR OR POINT TO POINT

STABLE

High stability (.003%) under normal operating conditions.

RUGGED

Components conservatively rated. Completely tropicalized.

Model 446 transmitter operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.5-24.0 Mcs (1.6-2.5 Mcs available). Operates on one frequency at a time; channeling time 2 seconds. Carrier power 350 watts, A1 or A3. Stability .003%. Operates in ambient -35° to 45°C. Nominal 220 volt, 50/60 cycle supply. Conservatively rated, sturdily constructed. Complete technical data on request.

Here's the ideal general-purpose high-frequency transmitter! Model 446... 4-channel, 6-frequency, medium power, high stability. Suitable for point-to-point or ground-to-air communication. Can be remotely located from operating position. Co-axial fitting to accept frequency shift signals.

A-100

AER -O- COM

3090 DOUGLAS ROAD MIAMI 33, FLA.

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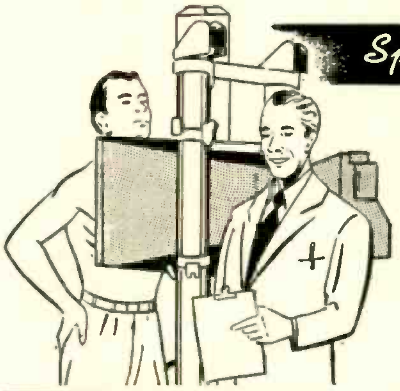

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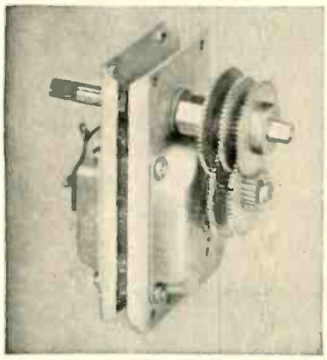
Manufacturing X-Ray equipment calls for precision and dependability in every part.

That's why, when the nation's three leading manufacturers of X-Ray machines chose the motor that moves the delicate negative holders, they selected motors designed and built by EEPCO.

These tiny motors of 1/500 h.p. (intermittent service) provide the reliable, steady source of power that revolves the negative changing mechanism. After a photo is made, the exposed negative with its lens and shutter, are automatically moved aside and a new unit moved into the ready position. Handling this task demands an even, slow application of power to avoid damage to the delicate mechanism. This is typical of the many unusual applications to which EEPCO-designed motors have been put.

If your particular problem calls for special design, or merely for standard motors that can handle the toughest service, you'll find that EEPCO is the source on which to depend. Out of the many unusual requirements filled by EEPCO engineers has come experience unsurpassed in industry and always at your disposal.

Equally important, the EEPCO plant is well-equipped and staffed to turn out motors for you on a mass-production, low-cost basis when necessary.



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(Advertisement)

ULTRA* SENSITIVE RELAYS—

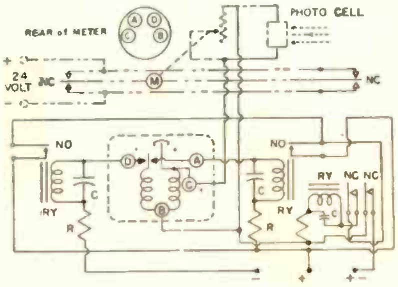
High Speed Operation—
A customer came in recently bringing with him a breadboard using one of our non-indicating meter-relays. We were astonished to see this relay working at 60 times per second. Until then we had thought it impractical to run one faster than 5 per second.

We haven't permission to use his name which is too bad. We'd like to give him credit. His circuit is reproduced here. It is like our drawing 2396-32 (Bulletin 112) with modifications. Delay on all relays is cut way down. Each has 1.0 Mfd for time delay. Load relays hold just long enough to prevent fluttering with the interrupter. The interrupter is connected through contacts on the load relays so it works only when needed.

All spring action is taken out of the meter contacts so they will follow at this speed. Contacts carry 15 milliamperes for strong locking action. Spacing between contacts is .05" for short travel—still there is enough separation to prevent false operation under shock or vibration.

Input is from a photocell. The equipment is self balancing. It maintains fixed output from the cell under varying light intensities. Contacts in the meter actuate a reversible motor (through intermediate relays*) which drives a rheostat in the cell output.

15 microamperes holds this relay in center position. Low limit contact makes at 14—high at 16. A change of 1 microampere starts the correction motor. Response time is less than 4 seconds for full rotation.



*See page 12 Scientific American, April 1954. This leading maker of infra sensitive relays refers to ours as "a couple of orders more sensitive." Hence "ULTRA."

ASSEMBLY PRODUCTS, INC.

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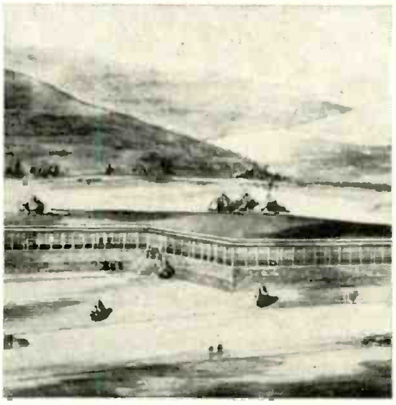
TRESCO (Transformer and Electronic Specialties Co.), Philadelphia 28, Pa.; Viking Electric, Los Angeles 17, Calif.; Wire Company of America, Santa Barbara, Calif.



Micamold Radio Opens New Factory In Virginia

MICAMOLD RADIO opened the first of two branch factories to be built in Tazewell, Virginia. Production is already underway at the new plant.

The Tazewell site occupies 70,000 sq ft of space. Nearly 500 employees will be employed there and another 500 will work at the proposed second Micamold plant when it is completed.

Daystrom Instrument Promotes Mageoch

NELSON H. MAGEOCH was promoted to vice-president of Daystrom Instrument.

Mageoch has been director of engineering and research at the instrument plant since 1951. He has held executive positions with Atwater Kent, Philadelphia Electric

ELIMINATE HEADACHES!

...in purchasing

VINYL SLEEVING

It's far easier to buy vinyl sleeving from Resin Industries for these important reasons: 1. Meticulous compounding by skilled chemists assures strict adherence to exacting specifications. 2. Precision workmanship. 3. Rigid quality control guarantees uniformity. 4. Prompt and understanding service. No wonder Resinite is the *largest* supplier of vinyl sleeving to the aircraft industry. Write for samples and prices.

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SPECIALISTS IN VINYL SLEEVING AND TUBING FOR THE AIRCRAFT, ELECTRONICS, AND MEDICAL FIELDS

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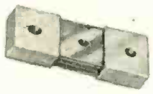
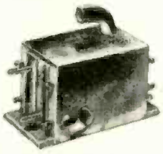


INSTRUMENT SHUNTS



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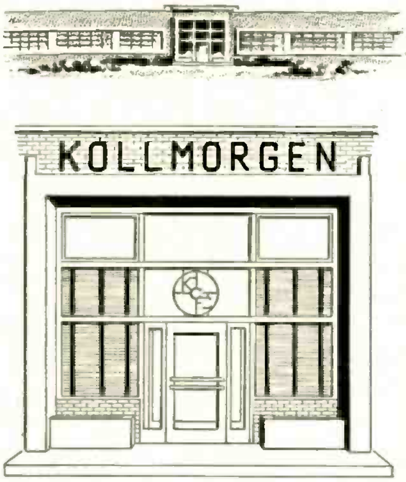

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For nearly half a century Kollmorgen has designed, developed and manufactured precision optics and optical systems for industry and the military.

We have the engineering "know-how", the design personnel and the manufacturing capacity to help you solve your optical problem.

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and Western Electric before joining Daystrom.

In his new capacity he will continue to direct engineering and research activities at the Archbald, Pa. plant, together with industrial engineering, equipment installation, inspection and test.

Apparatus Makers Elect Officers

EDWARD J. ALBERT of Thwing-Albert Instrument was re-elected president of the Scientific Apparatus Makers Association.

T. M. Mints of E. H. Sargent was also re-elected to another term as treasurer of SAMA.

Newly elected chairmen of the association's six sections include: Industrial Instrument, J. Robert James of James G. Biddle Co.; Laboratory Apparatus, E. J. Rhein of Kimble Glass; Laboratory Equipment, O. L. Lethander of Leonard Peterson & Co.; Optical, L. B. McKinley of Bausch & Lomb; Nautical, Aeronautical & Military Instruments, P. R. Bassett of Sperry Gyroscope and B. H. Bristol of The Foxboro Co.

Directors-at-large of SAMA for the following year include: C. G. Campbell of Kewaunee Mfg. Co.; H. F. Dever of Minneapolis-Honeywell; A. W. Fisher of Fisher Scientific; H. B. Richmond of General Radio; G. W. Tall, Jr. of Leeds & Northrup and R. E. Welch of W. M. Welch Manufacturing.

Johnson Named By Purdue

STUART JOHNSON, professor of electrical engineering and assistant dean of engineering at the University of Florida, will succeed D. D. Ewing, who is retiring, as head of Purdue's School of Electrical Engineering.

Dr. Johnson served on the teaching and research staffs of the Iowa State College and at the Missouri School of Mines. In 1946, he was appointed associate professor of electrical engineering at the University of Florida, and in 1947 he was promoted to professor of electrical engineering and was assistant dean of engineering.

During World War II, he served

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Resistance is high

. . . with **LUNDEY** miniature hermetic terminals!

TESTS PROVE — Lundey series #199 miniature hermetic terminals give excellent performance under conditions of high humidity.

In an average test the following results were tabulated:

Relative Humidity	Temp.	Insulation Resistance
90%	80°F	1,000,000 megohms
50%	80°F	3,000,000 megohms

OTHER FEATURES

Mounting in simple drilled or punched holes . . . no extrusion needed.
Effective spring loading
Teflon external member
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Minimum mounting — 15/64" on centers
Voltage rating — 500V RMS operating
Current rating — 8 amperes
Three electrode styles available
Production-proved
Meets MIL-T-27 specifications

If humidity creates a problem for you, let Lundey terminals help you solve it. Write for Bulletin #199, Dept. E.

LUNDEY ASSOCIATES
694 Main Street, Waltham 54, Mass.

This ONE instrument checks RF, IF, and AF performance of receivers.

MODEL 82

Standard Signal Generator

20 cycles-50 mc.

FEATURES:

- Continuous frequency coverage from 20 cycles to 50 mc.
- Direct-reading individually calibrated dials.
- Low harmonic content.
- Accurate, metered output.
- Mutual inductance type attenuator for high frequency oscillator.
- Stray field and leakage negligible.
- Completely self-contained.

SPECIFICATIONS:

FREQUENCY RANGE: 20 cycles to 200 Kc. in four ranges. 80 Kc. to 50 Mc. in seven ranges.

OUTPUT VOLTAGE: 0 to 50 volts across 7500 ohms from 20 cycles to 200 Kc. 0.1 microvolt to 1 volt across 50 ohms over most of range from 80 Kc. to 50 Mc.

MODULATION: Continuously variable 0 to 50% from 20 cycles to 20 Kc.

POWER SUPPLY: 117 volts, 50/60 cycles. 75 watts.

DIMENSIONS: 15" x 19" x 12". Weight, 50 lbs.

Laboratory Standards

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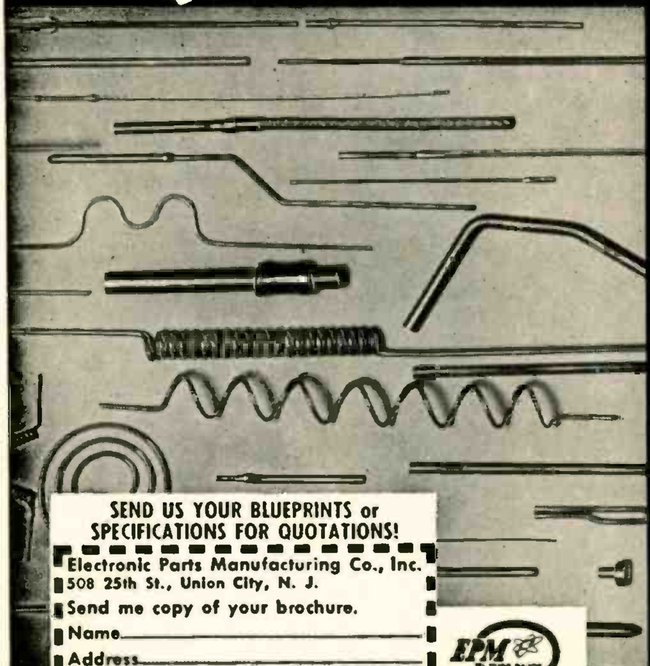

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in the U. S. Navy as an electronics officer.

His industrial experience covers employment with Century Electric, General Electric, Westinghouse Florida Power and Light.

Briggs Opens Consulting Offices

THOMAS H. BRIGGS has opened offices in Norristown, Pa. as an electronics consultant in the fields of materials, processing and applications of electron tubes and also in the field of automation and printed wiring.

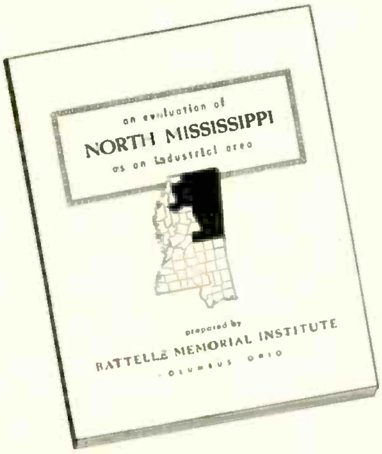
Briggs' recent professional experience was with the Burroughs Research Center as manager of the engineering services department. For five years he was head of the electronics laboratory at Superior Tube in Norristown, Pa. Previously he had served as chief factory engineer at the RCA special purpose tube factory and at Raytheon's receiving tube plant.

AMF Promotes Engineering Executives

RODNEY C. GOTT, a director and vice-president of American Machine & Foundry, has been named executive vice-president of the company. R. A. Kimes, former manager of the company's general engineering laboratories in Greenwich, Conn., has been named director of engineering of the electronics division in Boston. T. R. Dreyer has been appointed divisional vice-president and general manager of the firm's

Rodney C. Gott

Detailed, Unbiased . . .


an evaluation of
NORTH MISSISSIPPI
as an industrial area
prepared by
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COLUMBUS OHIO

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MEMORIAL INSTITUTE OF COLUMBUS, OHIO

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Harry W. Clark, *Executive Director*

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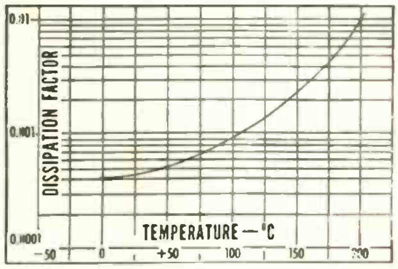
VITRAMON CAPACITORS

by operating at higher efficiency
teamed with other quality components, give

LOW LOSS

to your circuit systems

The excellent dissipation factor of the dielectric, and its thorough bonding to high-conductivity silver electrodes, assure a very low loss factor. As shown in the adjacent curve, the dissipation factor at 25 C and 1 mc is equivalent to a Q of 3000.



Temperature Characteristic

Vitramon Capacitors are tough and tiny. Their fine-silver electrodes are buried in a monolithic block of fused porcelain dielectric. This structure assures optimum electrical qualities in all capacities, 0.5 through 2000 $\mu\mu$f.

Write today for complete data.

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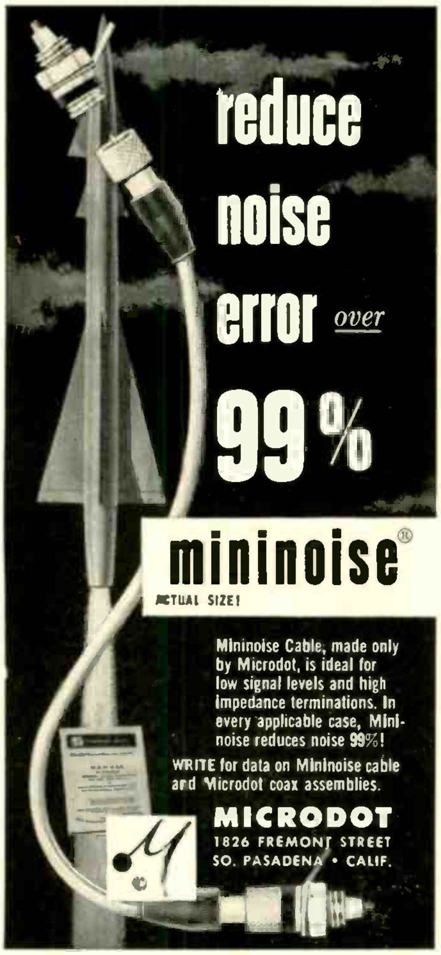
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error *over*
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ACTUAL SIZE!

Mininoise Cable, made only by Microdot, is ideal for low signal levels and high impedance terminations. In every applicable case, Mininoise reduces noise 99%!

WRITE for data on Mininoise cable and Microdot coax assemblies.

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NEW MULTIMETER KIT $26.50
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BUILD YOUR OWN — INCREASE KNOWLEDGE — SAVE MONEY — BUY DIRECT FROM MANUFACTURER . . . Top quality instruments in kit form featuring latest design and circuit developments. Completely detailed step-by-step construction manual — clear pictorials — complete schematics. All sheet metal work punched, formed and finished. Low kit prices include tubes, chassis, cabinet and all necessary constructional components.

Kits for the school — service shop — industrial laboratory — hobbyist, etc.

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BENTON HARBOR 14,
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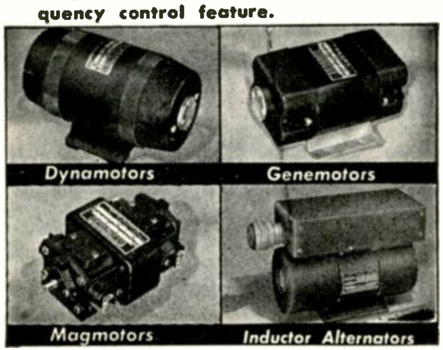
COMPACT
DEPENDABLE
EFFICIENT
Rotary Power
by Carter

THE NEW
Custom
DC-AC CONVERTER

These latest of all Carter DC to AC Converters are specially engineered for professional and commercial applications requiring a high capacity source of 60 cycle AC from a DC power supply. Operates from storage batteries, or from DC line voltage. Three "Custom" models, delivering 300, 400, or 500 watts 115 or 220 V. AC. Wide range of input voltage, 12, 24, 32, 64, 110 or 230 V. DC. Unequalled capacity for operating professional recording, sound movie equipment and large screen TV receivers. Available with or without manual frequency control feature.



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Carter Rotary Power Supplies are made in a wide variety of types and capacities for communications, laboratory and industrial applications. Used in aircraft, marine, and mobile radio, geophysical instruments, ignition, timing, etc. MAIL COUPON NOW for complete Dynamotor and Converter Catalogs, with specifications and performance charts on the complete line.

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Please send new catalogs containing complete information on Carter "Custom" Converters and other Rotary Power Supplies.
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R. A. Kimes

manufacturing division. George F. Crosby, formerly works manager of Pyrene Manufacturing, has been named works manager of the electronics division.

Gott has been vice-president in charge of AMF's general products group and commercial research development since April, 1951. He was elected to the board of directors two years later. He joined the firm in 1946.

Kimes served as manager of the general engineering laboratories since their establishment in Greenwich in June, 1953. Prior to this appointment, he was manager and assistant manager of the company's engineering division's special products department.

In 1949 he was appointed director of overseas project contracts for AMF's International Division. Kimes joined the firm in 1946 as assistant to the works manager of the Buffalo plant. He was previously with Western Electric in engineering activities.

Dreyer directs the manufacturing activities of AMF factories in Buffalo, Boston, Glen Rock, Pa., New Haven, Conn., and Brooklyn.

He joined the company in 1952 as works manager of two plants. Last year he was named director of manufacturing of five plants for the firm.

Prior to joining the firm he was with American Type Founders as project manager. Immediately before that he was on the staff of the consulting engineering firm of Morris & Van Wormer. From 1940 to 1950 he was associated with the E. W. Bliss Company of Canton,

Caltech
Jet Propulsion
Laboratory

. . . is now offering select engineering positions requiring a considerable degree of initiative, creative ability and responsibility.

System Analysis Engineer
For analysis, study, and evaluation of guided missile systems.

Radar, Doppler, Antenna Engineers
Several responsible positions are available for engineers experienced in micro wave, audio, pulse, antenna, and other circuits relevant to radar and doppler systems.

Gyro Engineer
Position involves the development and design of gyros, accelerometers and gimbaled systems. Experience with precision instrumentation techniques is desirable.

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With development experience in circuit design, logical design, transistors or theory of automatic control computers.

Mechanical Engineers
For design and development of small auxiliary power supplies. Experience with air turbines, reciprocating gasoline engines, gas turbines or electric alternators is desirable.

Electronic Physicist
For investigation into the basic physical phenomenon occurring in electronics. An immediate problem is the investigation of ammonia absorption oscillators.

Experience in the respective fields is required.
Send your resume today to:

JET PROPULSION LABORATORY
California Institute of Technology
4800 Oak Grove Drive
Pasadena 3, California

T. R. Dreyer

Ohio, serving as general superintendent of the Brooklyn plant and also as factory manager of the Salem, Ohio plant.

Crosby was previously associated with Pyrene Manufacturing as works manager from 1948 to 1954. Before that, he was executive assistant to the vice-president of manufacturing of M. W. Kellog.

IRC Changes Name Of California Subsidiary

INTERNATIONAL RESISTANCE changed the name of its California subsidiary, Gorman Manufacturing, to Ircal Industries.

Edward A. Stevens, vice-president and treasurer of IRC, has been elected president of the Los Angeles concern. Purchased by IRC in June of 1953, Ircal Industries is specializing in the manufacture of encapsulated wire wound precision resistors.

Eutectic Opens New Plant In Canada

A NEW FACTORY with an area of 10,000 sq. ft. has been acquired by Eutectic Welding Alloys of Canada in Montreal.

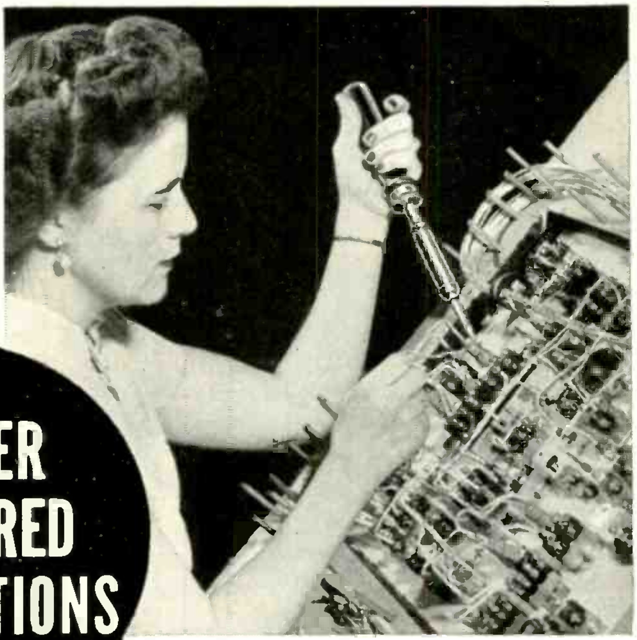
Production will begin almost immediately and goods will be shipped direct from the plant.

City Takes Title To Federal Plant

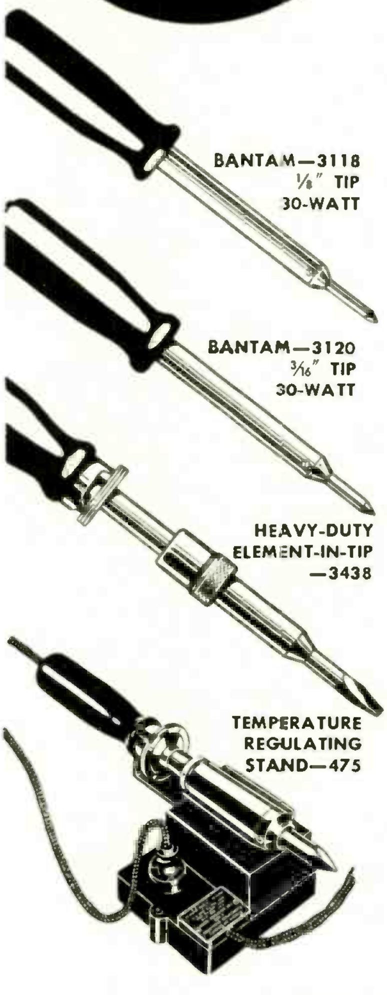
THE CITY OF NEW YORK has taken title to Federal Mfg. & Engineer-

American Beauty

ELECTRIC SOLDERING IRONS for



BETTER SOLDERED CONNECTIONS



DEPENDABLE . . . DURABLE . . . EFFICIENT. Since 1894 American Beauty Electric Soldering Irons have been the standard for performance for all soldering irons.

NOW . . . American Beauty gives you precision production soldering with the new BANTAM—a light, sturdy, quick-heating soldering iron with small-diameter tip.

HEAVY-DUTY ELEMENT-IN-TIP—3438

A different, more efficient electric soldering iron than any on the market. An iron designed especially for heavy-duty or production-line use. It embodies a new type of heat application with the element permanently-embedded in the tip.

TEMPERATURE REGULATING STAND 475

Set the thermostat at the desired temperature—your iron will be ready to use without waiting.

WRITE FOR DESCRIPTIVE LITERATURE

SINCE 1894—ALWAYS DEPENDABLE

American Electrical Heater Company

DETROIT 2, MICHIGAN

American Beauty ELECTRIC IRONS 60 YEARS YOUNG 1894 1954

NO. 140-H

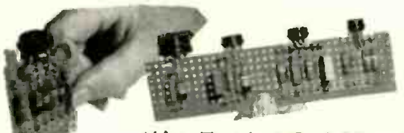
New Components for designing Electronic Equipment for RELIABILITY-IN-SERVICE

Alden Components for Plug-in Unit Construction enable you to design to these Bold New Standards —

1. Circuitry subdivided function by function into plug-in units.
2. Tiny Tell-Tales spot troubles instantly.
3. Plug in replacement spares in 30 seconds.
4. All leads brought to single accessible point of check, numbered and color coded so layman can make first-level tests.

It's as simple as this —

1 Organize your circuitry function by function in compact vertical planes using Alden Terminal Mounting Cards, Ratchet-Slot Terminals and Card-mounting Sockets.

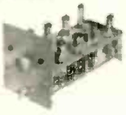


Alden Terminal Card Mounting System — for Packages — for Chassis.

2 Mount the circuitry planes in Alden Plug-in Packages and Basic Chasses which can be yanked out and replaced in 30 seconds.

ALDEN PLUG-IN PACKAGES 7, 9, 11 & 20-PIN

ALDEN BASIC CHASSIS 2", 4", 8" & 17" WIDTHS



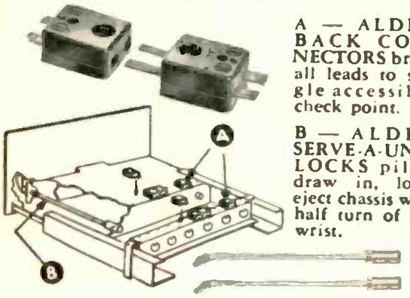
3 Monitor each plug-in unit with tiny Alden Tell-Tales that spot trouble instantly, permit checks while operating, from front of panel.

ALDEN MINI-TEST POINT JACK #110BCS

ALDEN MINIATURE PAN-i-LITE #86L

ALDEN MINIATURE FUSE-LITE #440-4FH

4 Centralize unit interwiring at a single accessible point of check, with Alden Back Connectors and Serve-A-Unit Lock which allow color coding and symboling that "reads like a book".

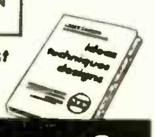


A — ALDEN BACK CONNECTORS bring all leads to single accessible check point.

B — ALDEN SERVE-A-UNIT LOCKS pilot, draw in, lock, eject chassis with half turn of the wrist.

ALL THIS CAN BE ACCOMPLISHED WITH STANDARD ALDEN COMPONENTS

To get details request free: "Plug-in Handbook Data"



ALDEN PRODUCTS CO.

7127 N. Main St., Brockton 64, Mass.

ing's main plant in Brooklyn to make way for a housing and college development program.

The company will continue operating at the plant indefinitely while seeking a new manufacturing site covering approximately 100,000 sq ft.

Neptune Acquires Cox and Stevens

COX AND STEVENS Aircraft, maker of electronic scales, has been acquired by Neptune Meter.

The move is part of Neptune's program of diversification and expansion in the field of measurement.

Other subsidiaries acquired by Neptune this year are Revere Corporation of America in Wallingford, Conn. and Electronic Instrument and Signal Co., of Meriden, Conn.

Automatic Electric Appoints Clark

DANIEL E. CLARK, engineer in charge of transistor development for Automatic Electric, has been appointed chief electronics engineer, a newly created executive position.

He will give executive direction to the use of electronics in Automatic Electric's products.

Dr. Clark has served on the faculty of Northwestern University as an instructor in electronics.

In addition to his ten years' employment at Automatic Electric, Clark has been employed by R. W. Hunt, Armour Research Foundation

EXTREME STABILITY

GIANNINI

VOLTAGE DIVIDER

Uniform performance—even when exposed to severe temperature changes, corrosive atmosphere and high humidity—makes the Giannini Fixed Voltage Divider ideal in aircraft or varied industrial applications. Freedom from the effects of vibration, shock and acceleration results from the new use of potting compounds and a continuous length of resistance wire.

GIANNINI
Voltage Divider
85174

Available with up to 23 voltage divisions—any spacing—high total resistance values.

Resistance tolerance for each section can be held to ± 0.5%.

Temperature coefficient of the wire may be matched—or as low as ±.00002 ohms/ohm/°C.

Length: 4-11/32"
Diameter: 1-3/4"
Mounting Flange: 1-13/16" square

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We'd be pleased to furnish more complete information — or assist you in a special problem.

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ElectroMechanical Division
East Orange • New Jersey

AIRCRAFT SERVO COMPONENT

3 2 1
TRANS-SONICS INC
BEDFORD MASS
BARORESISTOR
PART NO
SER NO
7500 OHMS

The Type 71-5 Baroresistor is a pressure actuated potentiometer designed for operational use in aircraft. It features:

HERMETICALLY SEALED MECHANISM

The potentiometer winding and operating parts are hermetically sealed in a vacuum. Pressure is applied inside the bellows only. Therefore, the Type 71-5 Baroresistor is not affected by dust, fungi, or moisture.

RUGGEDIZED CONSTRUCTION

A special high force mechanism was developed for the Trans-Sonics Baroresistor to avoid the necessity for employing micro force potentiometer elements. Shock of 30g in any direction will not cause electrical discontinuity.

MACHINE CALIBRATION

Each instrument is calibrated by machine and its performance is automatically recorded as a graph of resistance versus pressure. Every turn of the winding is inspected. All electrical characteristics are automatically checked in an eleven stage inspection cycle.

TECHNICAL REPRESENTATIVES

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Condensed Data

Range: 0-14.7 psi, absolute
Resistance: 7500 ohms
Maximum voltage: 75 volts
Resolution: ⅓%
Accuracy: 2% of full scale

Typical Applications

Servos—Vary servo loop gain as a function of altitude.
Computers—Voltage divider, P total/P static.
Fire Control—Air density measurements.
Telemetering—Pressure transducer.
Recording—Pressure transducer.

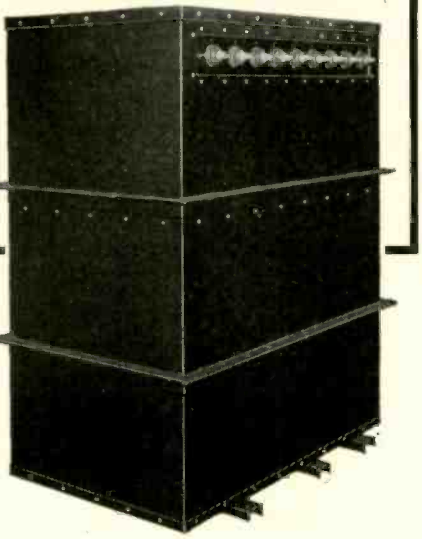
Write for
Bulletin No.
71-5 for
further details

Price:
$225.00
Short delivery

TRANS-SONICS, INC.

5 Forest Street Bedford, Mass.

CUSTOM BUILT TRANSFORMERS



Here is an example of the type of equipment we can build to specifications for research, laboratory or experimental work. This Acme Electric custom built transformer has a primary that can be varied from 12 volts thru 115 volts, with a frequency range from 7 cycles thru 60 cycles. Nominal output voltage, 33,000 volts.

This unit was built for use in connection with high voltage electrostatic separation and collection of various types of atmospheric particles.

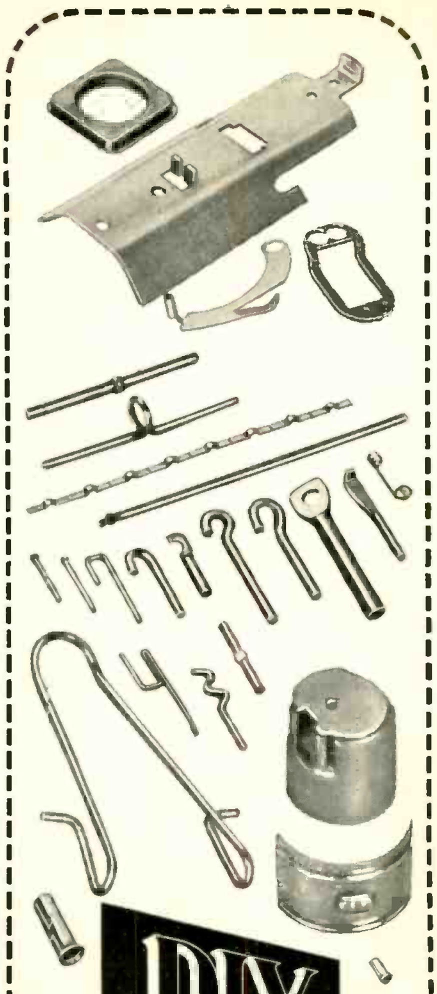
Designing a Dry Type transformer in this voltage class that provides safe and efficient performance, is another notable example of Acme Electric transformer engineering.

ACME ELECTRIC CORPORATION

MAIN PLANT: 317 WATER ST., CUBA, NEW YORK

West Coast Engineering Laboratories: 1375 W. Jefferson Blvd. • Los Angeles, Calif.
In Canada: ACME ELECTRIC CORP. LTD. • 50 Northline Rd. • Toronto, Ontario

Acme ACME Electric



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Dependable • Precision Wire Forming and Stamping Specialists

Precision Parts to meet your Production and Engineering needs. From .002" dia. to .125" dia. Radio tube parts—Stampings—Drawings. Modern facilities, high-production equipment.

Send sketch or print for quotation.

PIX

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you could make your own electricity...

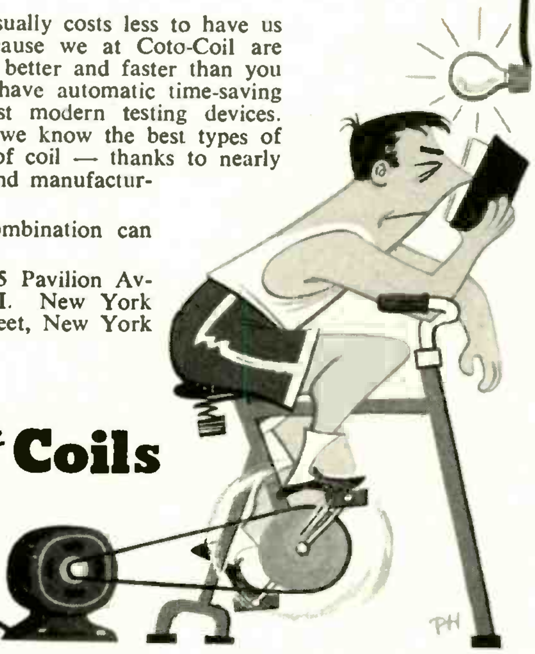
But in the long run it costs less to deal with the public utility company.

In the same way, it usually costs less to have us make your coils — because we at Coto-Coil are specialists, doing the job better and faster than you can do it yourself. We have automatic time-saving equipment, and the most modern testing devices. Without trial and error, we know the best types of materials for each type of coil — thanks to nearly 40 years of coil design and manufacturing experience.

Find out how this combination can cut costs for *you*.

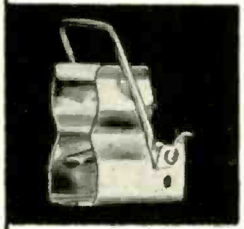
Coto-Coil Company, 65 Pavilion Avenue, Providence 5, R. I. New York Office: 10 East 43rd Street, New York 17, N. Y.

Coto PRECISION WOUND Coils



VIBRATION and SHOCK CLIPS

MINIATURE and SUBMINIATURE TUBE and COMPONENT HOLDERS
Tested to withstand 20 G's at 500 cycles, without resonant frequencies. Made of Cadmium-plated Spring Steel. 180° contact surface full length of component. Sizes — .175, .195, .235, .260, .312, .375, .391, .400, .500, .562, .670, .750, 1.00, 1.12 diameters, with lengths up to 2". Available serrated, for sub-miniature tubes — with or without shields.



LOCKING CLIPS
Made to BuShips Spec. RE 28F121B — with silver, cadmium, nickel or alloy dip plating; ejecting and non-ejecting spring; with or without lugs, up to 5/8". Sizes (ferrule diameter) — 1 13/32", 9/16", 13/16", 1 1/8".

Fuse and resistor clips of all types — diode clips — molded Lucite cap nuts — Nylon machine screws and rivets. Send for catalog E

ATLAS E-E CORPORATION
BEDFORD, MASSACHUSETTS

and the Shakeproof Division of Illinois Tool Works. For the past two years he has devoted his time to the manufacture, evaluation, and application of transistors. Under his direction, laboratory facilities and pilot plant production of transistors have been established to provide the basis for study of transistors and their application in products manufacturer by the company.

Mansol Ceramics Moves Into New Plant

MANSOL CERAMICS moved into its new quarters in Belleville, N. J. With over 15,000 sq ft of new production space, the firm expects to increase production of its products.

The new factory and offices include a modern drafting and blueprinting department and a 1,000 sq ft explosion-proof room for experimentation. All new machinery has been installed in the plant.

Metal Powder Group Elects Officers

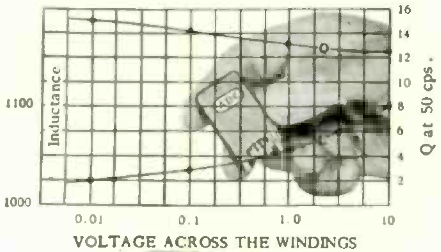
THE METAL POWDER ASSOCIATION elected officers and directors for 1954–55. Paul E. Weingart of American Metal Company was elected president succeeding T. R. Moore of General Dyestuff; William E. Cairnes of Radio Cores was elected chairman of the board; Robert L. Ziegfeld, secretary-treasurer of the association, was re-elected; Morris Boorky of The Pressmet Company was elected head of the fabricators division and vice-president of the association. Paul Weingart was elected head of the powder producers division. Carl Johnson of The Pressmet Company and Ralph B. Quelos of the Glidden

ADC SECOND IN A SERIES

TINY TRANSFORMERS
can pack a real wallop!

Ever wonder about Aladdin's genii? A lot of power to squeeze into one tiny container, yet we're doing something almost as unbelievable at ADC.

Take for example ADC's radically new line of tiny, hermetically sealed transformers and chokes. Measuring only 3/4" x 15/16" x 1-3/8", these tiny units have performance ratings equal to transformers and chokes of a far larger size. (Mu-metal cases.)



Curve showing Hi-Q, low frequency inductance illustrates the unusual characteristics of these tiny units.

Designed originally for the Geophysical field, modifications of these power-packed units are finding ready acceptance in transistor and other sub-miniaturized circuitry. Write for our unique catalog and data sheets on these tiny units.

ADC

AUDIO DEVELOPMENT COMPANY
2833 13th Avenue So., Minneapolis, Minn.

Company were both newly elected directors.

The balance of the board of directors consists of George Roberts of Vanadium Alloys Steel; Fred Lux of Lux Clock Manufacturing; B. T. duPont of National Radiator and Harrison Stackpole of Stackpole Carbon.

National Company Appoints Ruttenberg

ELLIOTT H. RUTTENBERG has been named price administrator for the National Company.

He was formerly with Raytheon as products manager in charge of the navigational aids division.

Previously, he was associated with Hallicrafters in Chicago as a senior project engineer. Earlier he was with Rauland as a project engineer.

Westinghouse Starts New Plant, Names V-P

A MULTI-MILLION dollar Westinghouse metals plant is now under construction in Blairsville, Pa., which is to bridge the gap between research and commercial application of new metals in the field.

The plant, which will be in operation by June 1955 will provide basic equipment for melting, forging, hot-rolling, cold-rolling, conditioning, pickling and heat-treating.

Donald C. Burnham has joined Westinghouse as vice-president in charge of manufacturing. He succeeds T. I. Phillips, who is retiring after 39 years of service.

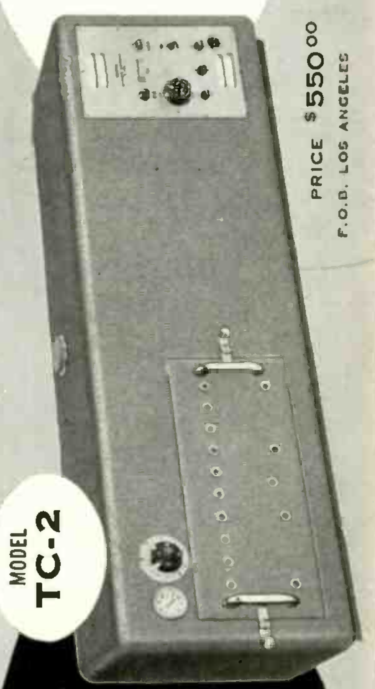
Burnham comes to Westinghouse from the General Motors, where he has recently held the positions of

The Model TC-2 Temperature Test Chamber is
a portable, self-contained, easy-to-operate unit ideal
for laboratory and production line use.
Write for literature.

Temperature Range: —65°F to +350°F.
Holding Accuracy: ±2°F.
Coolant: Dry ice, 15 lbs. capacity.
Dry Ice Loading Port.
Heater: Electric Strip Heater.
Control: Thermostat, balancing heat against dry ice evaporation. Permanent Thermometer.
Test Load Access: Removable tray, with 15 through ports.
Test Load Capacity: 600 cubic inches.
Power Requirements: 115 volts, 5 amperes, 50-60 cycles, single phase.

STATHAM DEVELOPMENT CORPORATION
12411 W. Olympic Blvd., Los Angeles 64, Calif.

PRICE $550.00
F.O.B. LOS ANGELES



MODEL
TC-2

FOR RAPID AMBIENT
TEMPERATURE TESTS . . .

PORTABLE
TEMPERATURE
TEST CHAMBER

SENSITIVE... small... rugged

THE NEW SERIES 100 RELAY
(Hermetically Sealed)

One of the greatest challenges in the field of electronics is the designing of components small enough and rugged enough for today's and tomorrow's "miracle" machines and equipment.

The engineers of the Signal Engineering & Mfg. Co., always alert to this challenge, now offer the new Series 100 Miniature Relay which is among the smallest and most sensitive of the double-pole type. It maintains high precision under varying conditions and is ideally suited to such equipment as military guided missile controls which must withstand extremes of shock, vibration, and temperature.

DIMENSIONS
1"x1"x1¾"

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Engineering
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SEALED RELAY

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MINIATURE ELECTRON TUBE CLAMPING SHIELDS
Patent pending

give *lower* bulb temperatures
and *increased* tube reliability!

First choice in tube shield clamps by the missile industry because, at no increase in weight, they reduce bare bulb temperatures 35% to 50% and operate successfully at 16G's from 0 to 2000 c.p.s.

Accepted for North American Aviation's missile program.

International
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MEETS ALL PRESENT AND FUTURE INDUSTRIAL AND MILITARY ELECTRONIC EQUIPMENT REQUIREMENTS!
TESTED • PROVEN • ACCEPTED • AVAILABLE!

manufacturing manager and assistant chief engineer of the Oldsmobile division. He previously was with Westinghouse from 1915 to 1952 and was on the president's staff in charge of manufacturing.

Condenser Products Expands Facilities

CONDENSER PRODUCTS of Chicago has expanded its production facilities by taking over 150,000 sq ft of space in the plant of New Haven Clock & Watch, the parent company, in New Haven, Conn.

The bulk of the production of the division's regular line of capacitors and high voltage power supplies has been transferred to New Haven along with the main sales and purchasing offices. Production of the regular line of pulse forming networks as well as all special work will continue to be carried on in the division's Chicago plant. The research and engineering department also will remain in Chicago.

Charles Bramble Joins Norden Laboratories

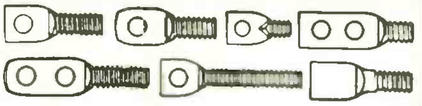
CHARLES C. BRAMBLE, former director of research at the Naval Proving Ground in Dahlgren, Va., has been named to the technical staff of the research and development division of Norden Laboratories.

In his capacity with Norden, Dr. Bramble will be a technical consultant in the fields of applied mathematics, mechanics, ballistics and computation. He will also be connected with technical coordination of major laboratory projects.

He was an instructor at the

SINCE 1920 QUALITY WENCO PRODUCTS

SPADE BOLTS



Specialists in designing and manufacturing All-Purpose Fasteners and Mounting Lugs. Tooled to produce over 1,000 sizes and styles of Spade Bolts in any finish, material or quantity.

OTHER PRODUCTS

Simplex
WIRE STRIPPERS & CUTTERS

- TOOLS AND DIES
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- WIRE SPECIALTIES
- REPLACEMENT TIPS for Electric Soldering Irons

Send samples or specifications for quotations.
Descriptive bulletin on request.

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WAXES

COMPOUNDS

Zophar Waxes, resins and compounds to impregnate, dip, seal, embed, or pot electronic and electrical equipment or components of all types; radio, television, etc.

Cold flows from 100°F. to 285°F.

Special waxes non-cracking at −76°F.

Compounds meeting Government specifications plain or fungus resistant.

Let us help you with your engineering problems.

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QUALITY AND SERVICE
108 YEARS
EXPERIENCE

ZOPHAR MILLS, INC.
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Versatility with a GREEN ENGRAVER

ENGRAVES
PANELS
DIALS
PLATES

Widely used in electronic and plastic fields, in machine tool shops and wherever permanent marking is needed. The GREEN ENGRAVER engraves equally well on metals, plastic, wood, hard rubber and glass. √ Fact-filled folder on request . . showing how economies in costs, labor and time are achieved with the GREEN ENGRAVER.

Mark your own symbols, numbers, lettering, on your small parts, tools, Identification and name plates . . . easily, simply, quickly . . . tracing from a master with the GREEN ENGRAVER.

√ Routs √ Models √ Profiles √ Engraves Etching attachment and other special equipment for industrial uses are available.

GREEN
INSTRUMENT COMPANY
363 PUTNAM AVE., CAMBRIDGE, MASS.

ANOTHER Rutherford PRECISION TIMING INSTRUMENT

MODEL (A-5)
TIME DELAY GENERATOR

MODEL A-5

An instrument of small size which provides accurate and variable time delays from 1 μs to 1,000 μs in three ranges.

- low jitter (.008%)
- linear scales
- highly stabilized power supplies
- small repetition rate effects
- blocking oscillator output
- trigger type input
- separate calibration adjustments for each range.

Get complete data:
our Bulletin E-A-5

Other Rutherford precision Time Delay Generators:
Model A-2 (.8 μs to 100,000 μs): Bulletin E-A-2
Model A-4 (10 μs to 10 secs): Bulletin E-A-4

Rutherford ELECTRONICS CO.
Telephone: TExas 0-4362
3707 S. ROBERTSON BLVD.
CULVER CITY, CALIFORNIA

NEW MODEL NO. BD4

LEDEX ROTARY SOLENOID

gives snap-action torque!

Now, with the addition of the new model BD4, Ledex Rotary Solenoids are available in seven basic sizes with various degrees of rotation and torque values up to 54 pound-inches. This new BD4 model offers the same compactness, ruggedness, versatility and dependable snap action as all the previously available sizes of Ledex.

Torque values for normal intermittent duty and 45° stroke.

Model No.	2	3	4	5	6	7	8
Diameter Inches	1 1/8	1 5/16	1 9/16	1 7/8	2 1/4	2 3/4	3 3/8
Torque lbs.-Inches	.4	1.0	1.7	4.0	7.5	25.0	54.0

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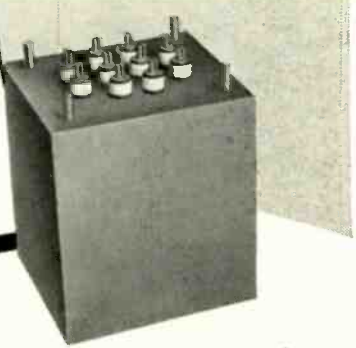

RG-60-D SERIES (RG-60-D-6, 27 and 115) with the following respective specifications — maximum DC output current of 4.5 A, 1.2 A and 225 MA; and Regulated output voltages of 6.0, 27 and 115 V DC.

Physical specifications — size: 4 5/16" x 3 11/16" x 4 1/2" high: hermetically sealed LB case; four 8-32 x 5/8" mounting studs; weight: 2 pounds, 3 ounces.

MD SERIES Servo Motor amplifiers specifications — MD-60-115-5: Supply voltage, 115 V, 60 cycles; output, 0-57 V RMS at 10 watts to control phase. Size, 2 1/2" x 2 1/2" x 3 3/8"; weight, 1 lb., 9 oz. MD-400-115-5: Supply voltage, 115 V, 400 cycles; output, 0-57 V RMS at 10 watts: to control phase. Size, 2 5/16" x 2 1/16" x 2 1/2", weight 14 oz.

Write for Technical Bulletins MA-1, 2.

ATLAS

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United States Naval Academy, and in 1939 he was transferred to the Naval Postgraduate school where he rose to the rank of senior professor of mathematics and mechanics. While at the postgraduate school he developed and introduced courses in ballistics and mathematical statistics.

During World War II he was called to active duty with the Navy and attained the rank of Captain. In 1942 he was placed in charge of the Exterior Ballistics Section of the Naval Proving Ground at Dahlgren. For this work he received a commendation from the Secretary of the Navy.

Lambda Names Weston Executive Vice-President

SIMEON WESTON, former chief engineer of Amperex Electronic Corp. of Hicksville, N. Y., has been elected executive vice-president of Lambda Electronics of Corona, N. Y.

Weston also has been associated with Federal Telephone and Radio, Radio Navigational Instrument and De Jur-Amsco.

He has been an instructor at Rutgers University and adj. professor of electronics in the Graduate School of Engineering of New York University.

Reps Elect National Officers

WALLY B. SWANK of the Empire State Chapter of "The Representatives" of Electronic Products Manufacturers, was elected national president of the organization.

Dean A. Lewis of the California Chapter moved from second vice-president to first vice-president. Ross C. Merchant of the Wolverine Chapter moved from third vice-president to second vice-president and John J. Kopple of the New York Chapter became the newly elected third vice-president.

Harry Halinton of Chicago will serve as national treasurer for the coming year and Dave M. Lee of the Pacific Northwest Chapter as national secretary

Hadden Named V-P Of Minshall Organ

George Howard Hadden has been promoted to vice-president in charge of engineering at the Minshall Organ Co. of Brattleboro, Vermont, manufacturers of electronic organs.

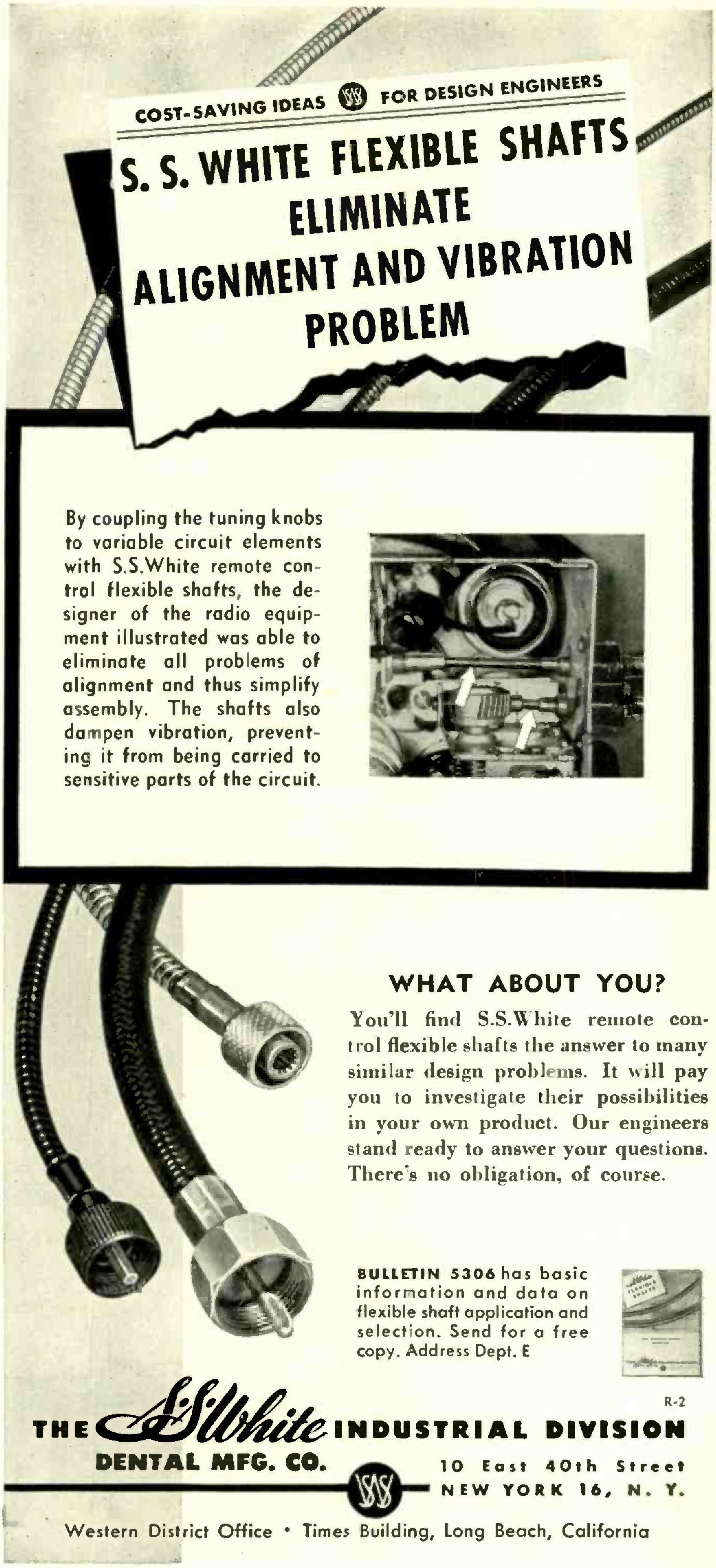
Hadden has been chief engineer of the Brattleboro plant since 1950. Prior to that he headed the engineering department of the company's plant in London, Ontario, Canada. He has been with the company since 1941.

DuKane Holds Standards Meeting

Robert Larson, chief audio-visual engineer of DuKane Corp. was chairman of the firm's industry-wide meeting held in Chicago to review recommended minimum standards for recording 30-50 cycle automatic sound strip-film productions. New recommended standards will be available from the company.

Transonics Plans Plant Expansion

Trans-Sonic of Bedford, Mass., manufacturer of electrical and electronic instruments, plans to relocate at Burlington, Massachusetts. The company plans to construct a new plant with 26,000 sq ft of space



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By coupling the tuning knobs to variable circuit elements with S.S.White remote control flexible shafts, the designer of the radio equipment illustrated was able to eliminate all problems of alignment and thus simplify assembly. The shafts also dampen vibration, preventing it from being carried to sensitive parts of the circuit.

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BULLETIN 5306 has basic information and data on flexible shaft application and selection. Send for a free copy. Address Dept. E

R-2

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Rapidly plots static and dynamic characteristics of *all* transistors — point contacts and junctions. Complete families of curves obtainable in 10 incremental steps for each of 5 ranges. Anomalies are disclosed by sweeping technique.

Presents on the scope:

Alpha vs. emitter current
•
Collector, emitter and transfer characteristics
•
Collector characteristics in grounded emitter connection

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Please send me your detailed Transistor Analyzer Technical Bulletin.
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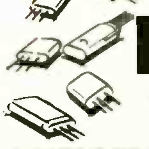

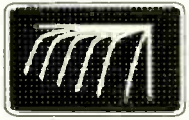

to house all of its research, engineering and manufacturing activities. The initial unit of the new plant will be built immediately and will double the company's present operating area. Two additional units of similar size are tentatively planned for future construction.

Taylor Receives Janeway Award

Lauriston S. Taylor of the National Bureau of Standards has been presented the Henry Harrington Janeway Award given annually by the American Radium Society for outstanding accomplishments in the field of applications of penetrating radiations in medical science.

Taylor, chief of the NBS atomic and radiation physics division, is responsible for direction of the research programs covering atomic and nuclear constants, electron physics, mass spectrometry, spectroscopy, radioactivity, X-rays, nucleonic instrumentation, high-voltage generators and accelerators such as the betatron and synchrotron, and the evaluation of radiation hazards and protective measures.

Before coming to the Bureau in 1927, Taylor served as a research fellow at Cornell University and worked briefly at the Bell Telephone Laboratories.

Edison Elects Houck, Names Engineer

Harry W. Houck was elected president of Measurements Corp., a subsidiary of Thomas A. Edison.

Houck joined Measurements shortly after its formation in 1939. The company currently produces standard signal generators and other electronic testing equipment. Holding a number of patents in the electronic field he has been responsible since 1941 for the operation of the firm which was purchased by Edison in June 1953. Made vice-president and general manager at that time Houck, as president, succeeds Henry G. Riter 3rd who continues as president of the parent company.

Alan P. Stansbury, formerly with the National Bureau of Standards

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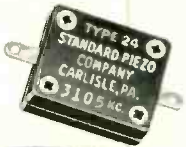

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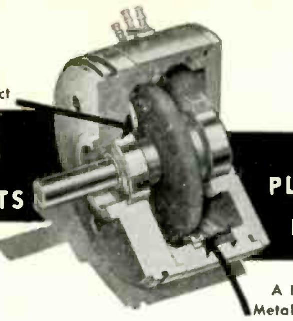
NEY'S SMALL PARTS PLAY A **BIG** PART IN PRECISION INSTRUMENTS


A Ney Precious Metal Alloy Contact
A Ney Precious Metal Alloy Contact

Illustrated above is a Helipot single-turn Model J Potentiometer using Ney Precious Metal Contacts. These contacts were designed to meet the special requirements of this instrument and assure the utmost in linearity and electrical output.

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This new super-heat wire, insulated with "TEFLON," is ideal for guided missile, jet and low-tension aircraft applications, transformer and coil leads. Sizes from AWG10 through 28. Also supplied with silver coated copper shields, and to individual customer requirements. Write for further information.

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Alan P. Stansbury

in Washington, D. C., has joined the Edison Research Laboratory to initiate electronic research and design as required by the various research programs carried out by the laboratory.

He started to work for the Department of Terrestrial Magnetism of Carnegie Institution of Washington, D. C. in the Fall of 1943, and was an observer at the University of Alaska Observatory.

In 1945 he transferred to NBS and was named assistant engineer in charge of the radio wave propagation field station in Trinidad, BWI.

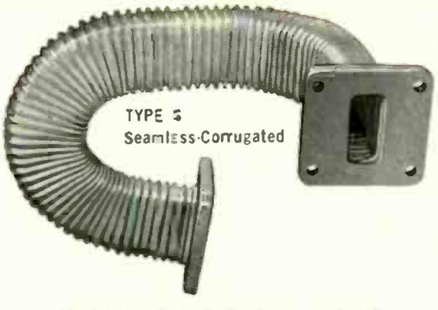
He was made head of the Equipment Development and Supply Group of the Field Operations Section of the Central Radio Propagation Laboratory in 1947.

Raytheon Plans Ceramics Plant

RAYTHEON plans to build a new plant in Waltham, Mass. to provide advanced development and production facilities for ceramics.

The new structure is to be attached to the present administration building and will provide 20,000 sq ft of floor space. Construction cost is estimated at somewhat more than a quarter-million dollars. A greater sum will be represented in the value of the equipment to be housed in the completed building.

The new building will house approximately 125 employees. It will have one of the largest conveyer kilns of its type for the firing of



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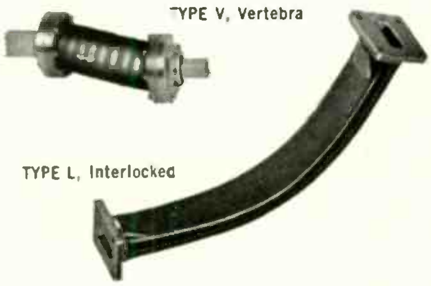

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ceramics, plus many special types of furnaces for such processes as sintering, reducing and fusing of powdered alloys, alumina, barium titanates and true ceramics.

Raytheon also announced that it will participate in MIT's cooperative course in electrical engineering.

Under the plan, engineering students of the school are selected for practical experience in the firms' laboratories and factories. Paralleling their academic pursuits with actual work in their chosen careers, these students upon graduation will be awarded simultaneously the degrees of Bachelor of Science and Master of Science.

RCA Cites Ned Owyang

NED K. OWYANG, right, manufacturing engineer at RCA's Tube Division explains changes in tube design to L. S. Thees, general commercial manager of the division, which won him citation in a company program to improve performance and life potential of RCA receiving tubes.

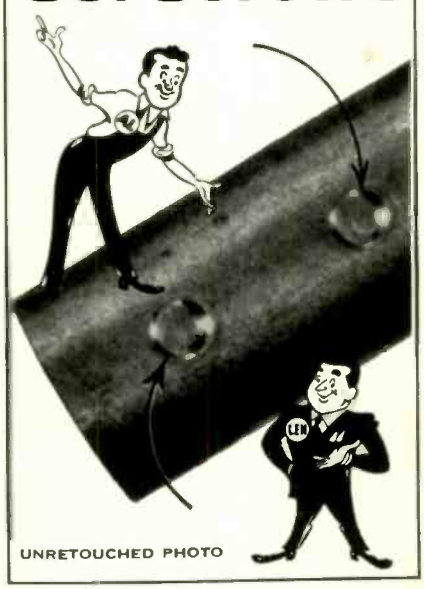
General Instrument Promotes Klabin

ROBERT L. KLABIN has been named vice-president and general manager of the newly-created Elizabeth Division of General Instrument.

The Elizabeth Division, for which Klabin will have full responsibility, is devoted largely to metal fabrication and processing, both on government and civilian contracts. Creation of the new Division is part of an overall company expansion program and is designed to increase operating efficiency.

Klabin joined the company in 1935 as a cost accountant and rose

The Shaft Shows the Holding Power of Allenpoint Set Screws



Loosen a set screw and look at the shaft it's pressing against. The set screw must make a full circle impression with no rough edges in order to give maximum holding power.

Allenpoint Set Screws drive smoothly and deeply into the shaft. Their even bearing surface gives increased resistance to rotation and sliding motion. Even on shafts of small diameter, Allen's smaller cup point assures top holding power.

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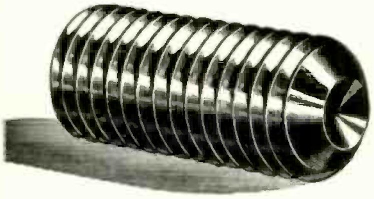
Industrial Distributors—specify Genuine
Allenpoint Set Screws



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Many engineers find that Panoramic's LP-1 expedites their entire measurements program. LP-1 analyzes sound vibrations and electrical waveforms quickly, conveniently, accurately. Designed to eliminate the tedious problems commonly associated with audio wave form analysis, the Panoramic technique provides valuable visual information *in seconds!*

- visualizes frequency and amplitude of waveform components between 40 and 20,000 cps; magnifies small portions of spectrum for detailed analysis; displays easily photographed; scans spectrum in 1-second; analyzes changing and static phenomena.

It will pay you to investigate the many unique advantages of LP-1.

- SPECIAL APPLICATIONS
- Investigations of closely spaced sound and vibration frequencies. Harmonic analysis of waveforms having low frequency fundamentals. Spectrum analysis requiring constant band width.
- Panoramic's LP-1 offers scores of unique advantages; it will pay you to check their application to your problems; write today for complete specifications.

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through the ranks to controller and general manager of the F. W. Sickles Division plant in Danielson, Conn., his most recent posts.

Benson Elected V-P By Gyromechanisms

GYROMECHANISMS of Halesite, L. I., N. Y., has elected Robert Benson as vice-president for its western division

Previously Benson was responsible for the design and development of American Gyro's products, and for the organization and management of their engineering department. In the last two years, he has been responsible for the design of miniature rate gyros for more than 60 different applications. He is co-inventor on three patents issued as a result of his work at North American Aviation on "isoelastic" ball bearings, a flotation gyroscope, and on an advanced stable platform for automatic navigation.

TV Plants Planned For Australia

ELECTRONICS INDUSTRIES of Melbourne plans to spend about $1.9 million on new factories and plants for the manufacture of tv receivers and tubes. The announcement followed a report by the Royal Commission on television in Australia, which suggested that tv be introduced without delay.

The managing director of the company, L. G. Warner, is in Europe studying developments in the field. He will visit England and then the U. S. to investigate further improvements. A branch office will be

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400~ servo motors

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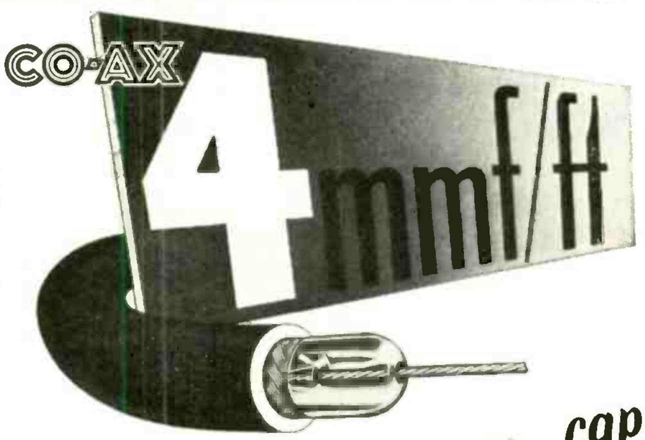

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C 11	6.3	173	.36"
C 2	6.3	171	.44"
C 22	5.5	184	.44"
C 3	5.4	197	.64"
C 33	4.8	220	.64"
C 4	4.6	229	1.03"
C 44	4.1	252	1.03"

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CAN BE CURED AT ROOM TEMPERATURE

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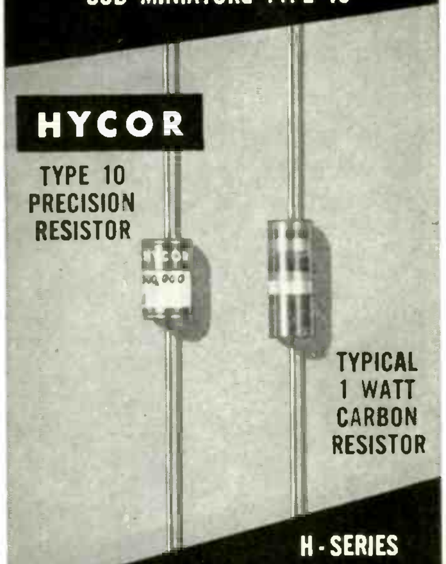

H-SERIES

Hermetically SEALED

PRECISION WIRE-WOUND

RESISTORS

The new Hycor "H" Series Precision Resistors incorporate unique design features that make it possible for the resistors to meet performance requirements far beyond those required by military specification.

The "H" Series Precision Resistors are encapsulated in a tough plastic compound. The result is a solid, homogeneous unit with unparalleled ruggedness, impervious to the effects of moisture, thermal shock and mechanical shock. The plastic is filled with heat conducting mineral which dissipates the heat and equalizes the "hot spots" in the resistor winding. The sealed-in terminal connections are welded.

SPECIFICATIONS...

MILITARY SPECIFICATIONS: Performance characteristics satisfy all requirements of MIL-R-93A and JAN-R-93.

TEMPERATURE COEFFICIENT: ±0.0022% per deg.C.

OPERATING TEMPERATURE: −65°C. to +125°C.

RESISTANCE ACCURACY: Standard resistance tolerances are 1%, 0.5%, 0.25% and 0.1%.

Type 10 (illustrated):
1/4" dia x 13/32" long;
Resistance range: 1.0 ohm - 0.35 meg.

Send for Bulletin H for complete description on other physical sizes and wattage ranges.

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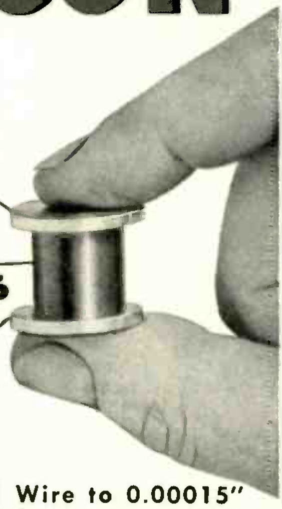

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In the never-ending conquest of the vast barriers of space and time, Douglas goes ever forward meeting every challenge that men and machines must face. The newest — and brightest — star in the aviation firmament, the Douglas DC-7, is truly a miracle of the mastery of men over machines . . . and in this great work sixteen A. W. Haydon timing devices play an important part. We at A. W. Haydon take pride in our contribution toward bringing a mass of metal and machinery into integrated performance which meets Douglas' high standards. Integrated performance is born of a multitude of small component parts, working in perfect mechanical and electrical coordination. The A. W. Haydon precision timing instruments are a vital part of this vast network.

DOUGLAS

DOUGLAS DC-7, the ultimate in comfortable and safe air travel. Swift, luxurious, dependable — the new DOUGLAS DC-7 justly deserves the accolades it is receiving.

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A. W. Haydon Time Delay Relay times duration of prop feathering.
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when timing poses a problem – consult

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Design and Manufacture of Electro-Mechanical Timing Devices

opened in England so as to keep in touch with new developments in the field.

Eliason Named By Air Associates

M. C. Eliason was appointed sales manager of the electronic equipment division of Air Associates, in Orange, N. J.

Eliason has been associated with the firm for more than seven years, having served as electronic engineer (1942–44) and electronic project engineer (1945–49) at the company's branch in Los Angeles and later at the company's Teterboro plant.

Earlier in his career, he was engaged in technical engineering and applied research for the California Institute of Technology. Just prior to his present appointment, he was systems engineer for the technical staff research and development laboratories at Hughes Aircraft.

Lueck Joins EMC Recordings

Laurence B. Lueck, formerly of the magnetic products division of Minnesota Mining and Manufacturing, has been appointed vice-president and general manager of E. M. C. Recordings of Saint Paul. He has been closely associated with the magnetic products division since its inception in 1948. Basic patents in the field of magnetic tape construction have been issued in his name.

E. M. C. Recordings (Educational—Musical—Cultural) will initially issue educational pre-recorded tapes in the school field. Plans later this fall call for an initial offering of

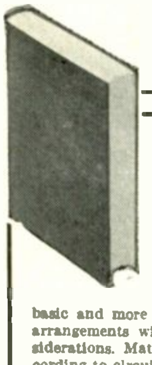
ACOUSTICS

Just Published!

A practical approach to better acoustics — for improved noise control, high fidelity music reproduction, and other applications. Uses the background of electrical engineers and communication physicists to solve a wide variety of acoustical problems. Discusses effects of sound in many aspects. By Leo L. Beranek, Technical Dir., Acoustics Lab., M.I.T. 467 pages, 312 illus., $9.00

MUSICAL ENGINEERING

Explains the theory and practice of interrelated phases of musical engineering—including speech, music, musical instruments, acoustics, and hearing. Treats the construction, range, characteristics, vibrating, and resonating systems of musical instruments. Analyzes each aspect of sound reproducing and pickup systems. Gives help toward better production of vocal and instrumental music, in acoustic design of studios, and problems in recording, transmission, and broadcasting. By Harry F. Olson, Dir. Acoustical Laboratory, RCA Laboratories, Princeton, N. J. 309 pages 303 illus., 28 tables, $7.00



MAGNETIC-AMPLIFIER CIRCUITS

A practical treatment of fundamental principles, characteristics, and applications. Logically develops the various kinds of basic and more complex magnetic amplifier circuit arrangements without extended mathematical considerations. Material is systematically classified according to circuit functions so you can compare and select solutions best suited to your special problem. By William A. Geyger U. S. Naval Ord. Lab. 277 pages, 135 illus., $6.00

PHYSICS AND APPLICATIONS OF SECONDARY ELECTRON EMISSION

Just Published!

A scientific treatment of this electronic phenomenon covering both physical and technical aspects. Moves step-by-step from basic theory to advanced aspects. Gives complete numerical data, methods, theory, and application. By H. Bruining, Senior Physicist, Philips Research Lab., Eindhoven, Netherlands. 178 pages, 135 illus., $5.50

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pre-recorded musical tapes. The firm will also issue a series of the great literature of the world on tape accompanied by background music. In addition, a tape playback unit will be marketed, to be offered under $40 retail.

Lear Readies California Plant

LEAR has completed a new administrative and manufacturing facility in Santa Monica, Calif.

The new 50,000 sq ft plant will be used for the manufacture of electronic equipment and is to serve as the administrative offices of the company's LearCal and research and development divisions.

The plant will provide manufacturing area, an engineering department, testing laboratories, office space and special quarters for development work on classified government contracts.

Pelavin Joins Simmonds

BERNARD J. PELAVIN was appointed project manager of the electronics development group at Simmonds Aerocessories.

Pelavin was design staff engineer for electrical and radio at Piasecki Helicopter. He has also been on the engineering staff of Glenn L. Martin and Fairchild.

From 1942 to 1945 he served with the U. S. Navy in the development of radar homing equipment for guided missiles.

Catholic University Names Killian

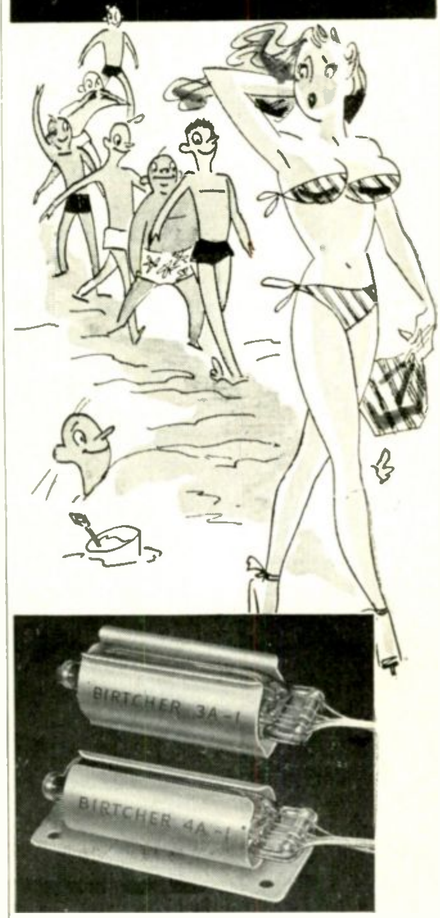
THOMAS J. KILLIAN, chief scientist of the office of ordnance research, U. S. Army, has been appointed Dean of the School of Engineering and Architecture of Catholic University of America in Washington, D. C. Dr. Killian will assume the position at the beginning of this academic year.

Gudeman Acquires Ceramic Condenser

GUDEMAN COMPANY of Chicago has purchased the ceramic condenser

YOU CAN'T SHAKE 'EM LOOSE!

BUT YOU CAN COOL 'EM OFF . . .



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BIRTCHER KOOL KLAMPS *will* help keep your subminiature tubes COOL . . . and hold them firm and secure, regardless of how they are shaken, or vibrated.

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SWEEPMASTER

Sweep Frequency Generators give you these outstanding advantages . . .

- Frequency Marker with an accuracy independent of Sweep Width. Inserted after external detection, it eliminates erroneous interpretation—eliminates possibility of undesirable transient distortion or limiting actions. The Marker is adjustable in amplitude and, after adjustment, remains independent of other controls.
- An attenuator whose performance is free of Frequency, assuring you that the Output Envelope is the same as that indicated by the Internal Monitor.
- A simple switching operation to permit examination of either Envelope of the Swept Frequency Signal.
- Durable, compact, lightweight Output and Detector Probes, either of which can be detached easily and replaced by cables having standard connectors.

SPECIFICATIONS

MODEL	CENTER FREQUENCY	RF OUTPUT 50 ohm * TERMINATION	SWEEPWIDTH CONTINUOUS ADJUSTMENT	FREQUENCY MARKER
SM I	100 KC to 11 MC	1 volt RMS	150 KC to 14 MC	100 KC to 11 MC
SM II	500 KC to 50 MC	0.2 volt RMS	150 KC to 20 MC	500 KC to 50 MC
SM III	500 KC to 75 MC	0.1 volt RMS	150 KC to 20 MC	500 KC to 75 MC

FLATNESS: Less than 1 DB variation over maximum sweepwidth range.
FREQUENCY MARKER: Engraved calibration accurate to ±2%.
HORIZONTAL DEFLECTION: A 60 cps sine wave for application to horizontal input of oscilloscope is supplied.
BLANKING: The RF signal may be operated continuously or blanked out for ½ of each 60 cycle period.
EXTERNAL DETECTOR: Blocking capacitor of 400 volt breakdown capacity.

*75 ohm available when specified

MANUFACTURERS ENGINEERING & EQUIPMENT CORP.
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division of Radio Ceramics of Angola, Indiana. The Indiana company disposed of the division in order to expand other lines. Gudeman will absorb it for expansion of its own line of capacitors. Thermflex division of Radio Ceramics will operate as Thermflex Corporation.

Ruge-deForest Names Childerhose

S. RICHARD CHILDERHOSE has been appointed works manager of Ruge-deForest.

He was formerly manager of production of analog computers for ship-borne gun fire control and airborne bombing systems at Norden Laboratories.

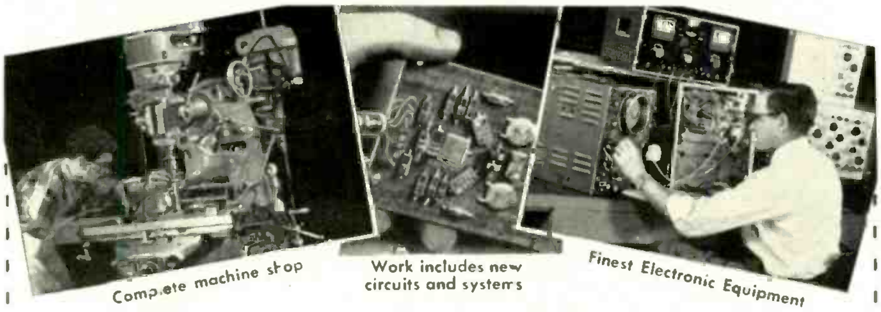
Bruno-New York Industries Expands

THE ASSETS of Computer Corporation of America have been purchased by Bruno-New York Industries. Computer has been established as a new division of Bruno to continue the manufacture of IDA analog computers, precision voltmeters and other products.

Active personnel of Computer Corp., will be retained, and Seymour Bosworth, formerly a vice-president of Computer, has been appointed general manager.

Bacon Opens Impregnation Facility

BACON INDUSTRIES has set up a new department to handle the vacuum impregnation of coils, trans-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INTERVIEWS BY APPOINTMENT

Charles D. Kepple, Professional Placement, Boston Engineering Lab.

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SOME PRACTICAL USES:

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Let the Dialco engineering department assist you in selecting the *right* lamp and the *most suitable* pilot light for your needs.

Dialco offers the *complete* line of pilot lights, from sub-miniature types to giant units with 1½" lenses.

Every assembly is available complete with lamp.

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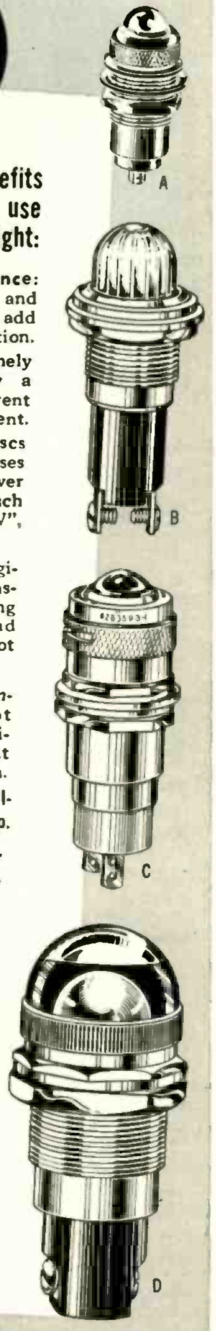

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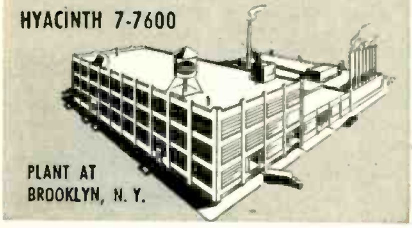

formers and other electrical components.

The department is set up to do both prototype work and large lot impregnations using standard or special impregnating compounds.

Bendix Promotes C. M. Granger

C. M. GRANGER, formerly assistant to the general manager, has been promoted to general factory manager of the television division of Bendix. A company veteran of 14 years' service, he will be responsible for all manufacturing departments and facilities of the division.

Yardney Electric Acquires New Building

A FIVE-STORY BUILDING in New York City, containing almost 70,000 sq ft of floor space, has been acquired by Yardney Electric, producer of silver-zinc batteries. The building contains facilities for engineering, research and consolidates production and engineering facilities under one roof. The firm employs approximately 250 production workers.

Federal Names Tube Head

FEDERAL TELECOMMUNICATION LABORATORIES appointed Albert G. Peifer as a department head in charge of low voltage vacuum tube development.

Peifer joined the Laboratories in 1950.

Syntronic Instruments Names Cahill

SYNTRONIC INSTRUMENTS of Addison, Ill. has appointed Bernard S. Cahill vice-president and chief engineer.

Cahill formerly was associated with Pioneer Electric and Research Corp. of Forest Park, Ill. He will supervise Syntronic's deflection yoke division.

Stokes Machine Plans Expansion

F. J. STOKES MACHINE Co. has launched a $1 million expansion pro-

FOR HIGH SPEED PRODUCTION TESTING

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Bruel & Kjaer Deviation Test Bridge, Model BL-1502

The Bruel & Kjaer Deviation Test Bridge is designed for checking electrical characteristics of production items at rates up to 4000 units per hour. The large simple dial permits fast reading without operator fatigue or inaccuracy.

This precision instrument indicates the percentage deviation from a standard of your choice. The measurement can be resistive, inductive, or capacitive.

For complete specifications on this and other Bruel & Kjaer instruments, write Brush Electronics Co., Dept. K-7, 3405 Perkins Ave., Cleveland 14, Ohio.

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Bruel & Kjaer instruments, world famous for their precision and workmanship, are distributed exclusively in the United States and Canada by Brush Electronics Company.

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BL-4304	Vibration Pickup
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BL-2109	Audio Frequency Spectrometer
BL-2304	Level Recorder
BL-2423	Megohmmeter and D.C. Voltmeter
BL-3423	Megohmmeter High Tension Accessory
BL-4002	Standing Wave Apparatus
BL-4111	Condenser Microphone
BL-4120	Microphone Calibration Apparatus and Accessory
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ELECTRONICS

gram that will enlarge its production facilities by another 40 percent. The new program follows closely an expansion of about the same scale which was completed early in 1951.

Ground will be broken for a 50,000 sq ft addition to the present Stokes plant in Northeast Philadelphia which will provide additional manufacturing space and larger office and engineering department accommodations. The new building is due to be completed by the end of the year.

Page Communications Engineers Organize

PAGE, CREUTZ, GARRISON AND WALDSCHMITT, consulting engineers in Washington, D. C., have formed a corporation, Page Communications Engineers, to take over the design, procurement, construction, installation, testing and operation of radio communications plants, systems, and equipment in the U. S. and foreign countries. The officers of the new corporation are: Esterly C. Page, president; Joseph A. Waldschmitt, executive vice-president; John Creutz, vice-president and treasurer; Charles J. Seeley, secretary and James L. Hollis is the chief engineer.

Jenner Named By Micro Switch

R. R. JENNER has been appointed director of airborne products for Micro Switch of Freeport, Ill., a division of Minneapolis-Honeywell.

Jenner was chief radio and electronics engineer at Beech Aircraft for 14 years.

Gillam Appointed Chief Engineer At Marconi

MARCONI WIRELESS TELEGRAPH announces the appointment of C. Gillam as chief engineer in the communications department. Gillam first joined the company in 1930. He has worked with the transmitter test section and the aerial design and systems divisions. He also spent 4 years in Turkey installing and maintaining high power broadcasting transmitters.

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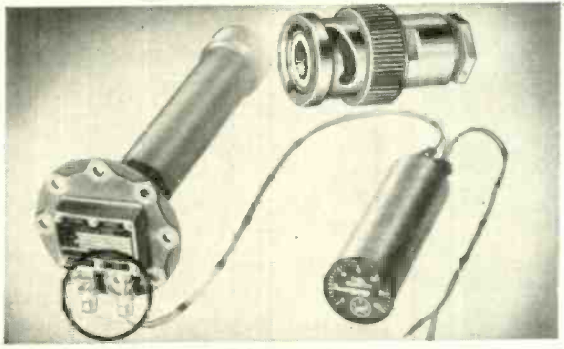

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Dage CBSN-552 Snap-on BNC Connector

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READ-RECORD HEADS

OPTIMUM READ-BACK SIGNAL
LOW NOISE FACTOR
HIGH FREQUENCY OPERATION

Librascope read-record heads are designed for recording and reading on magnetic drums or other magnetic storage systems and consist of a center-tapped coil wound on a toroidal core and molded into a temperature-stable epoxy resin package ¾" long. Optimum read-back signal at high frequencies is made possible by sintered ferrite core, a winding with low distributed capacity and with back gap eliminated. Positioning dowel hole permits precise mounting. All heads subjected to 1200 volt RMS high potential test. Write for catalog.

SPECIFICATIONS:
Crosstalk limited to minus 60 Db for adjacent heads. Resonant frequency above 500 KC
Track width: .090 in.
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NEW BOOKS

Thermionic Valves—Their Theory and Design

BY A. H. BECK. *Cambridge University Press*, 1954, 539 *pages*, $12.00.

THIS BOOK is divided into three sections. The first section covers the physical theory of electronics, the second covers the mathematical theory of electronics and the third discusses types of tubes. The information contained in these three sections represents the careful condensation by the author of the mass of information on the subjects considered.

In the first section, the basic theory of emission is discussed. Consideration is given to the theory of emission from pure metals and from oxide-coated emitters. Under the latter heading semiconductor theory and its possible application to oxide-coated cathodes are reviewed. Secondary emission, field emission and photoelectric emission are also discussed. In this presentation the Frohlich-Woodbridge theory and the Kadyshevich theory of secondary emission are presented in brief. This section concludes with a discussion of the properties of phosphors such as fluorescence and phosphorescence.

The section on the mathematical theory of electronics includes some analytical solutions of Laplace's equation with regard to potential problems. The solution of potential problems by conformal transformations is briefly considered. The rubber-sheet and electrolytic-trough techniques for determining potential fields are discussed. In this section, the basic theory of electron motion in magnetic fields and the principles of electron optics are also considered. Fluctuation noise in tubes is discussed, and the results of investigations by such men as Johnson, Nyquist, Campbell and North are briefly reviewed.

Section three, on types of tubes, constitutes one half of the book. In this section, the basic formulas for triode characteristics are derived. In addition, a very informative discussion of the theory of triodes for high frequencies is presented. The

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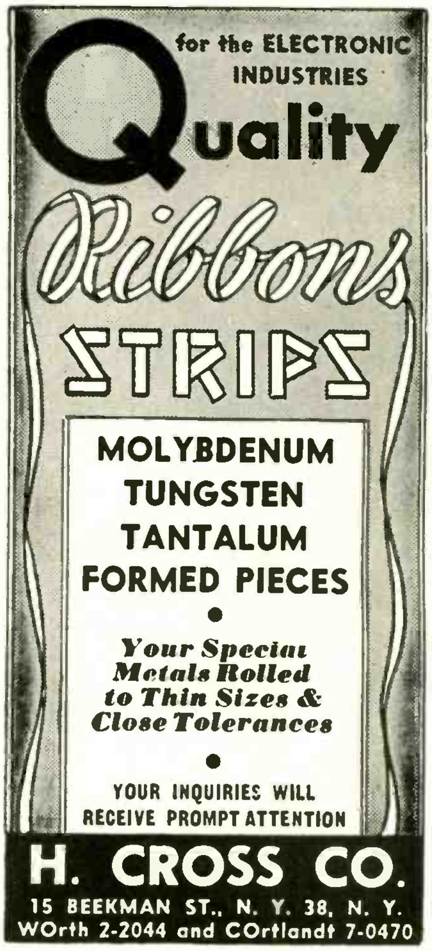

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Also, Transformers Made to Order

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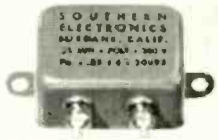
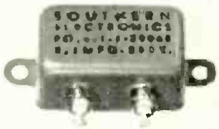
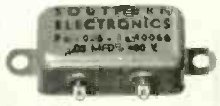


0.25 MFD. 1¾″ x 1¼″ x ⅞″



0.1 MFD. 1⅜″ x 1″ x ⅞″



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INSULATION RESISTANCE—10^6 MEG./MFD.
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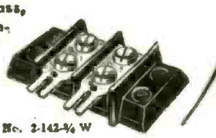

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Shown: Screw Terminals — Screw and Solder Terminals — Screw Terminal above, Panel with Solder Terminal below. For every need.

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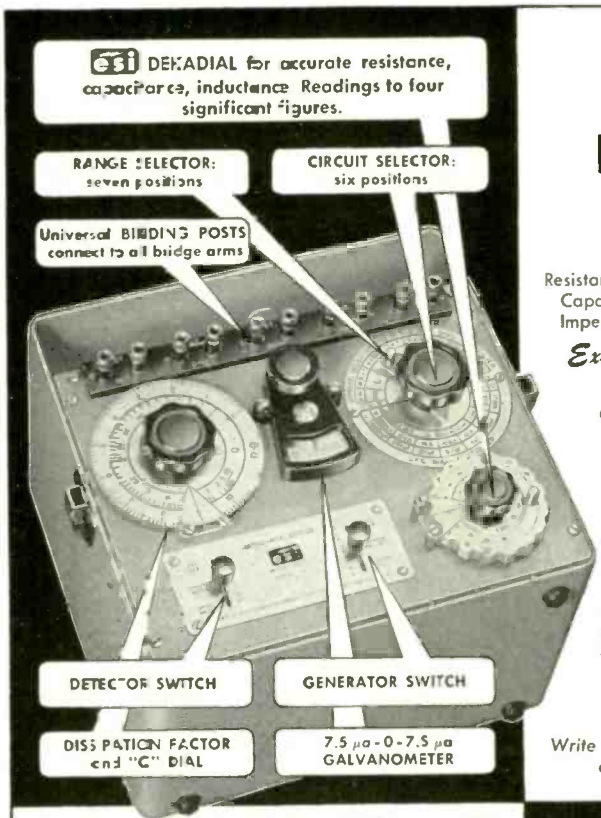
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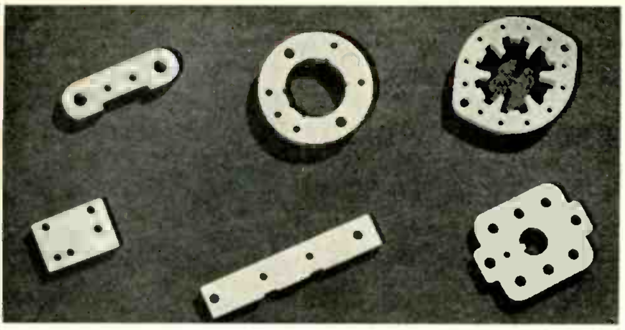

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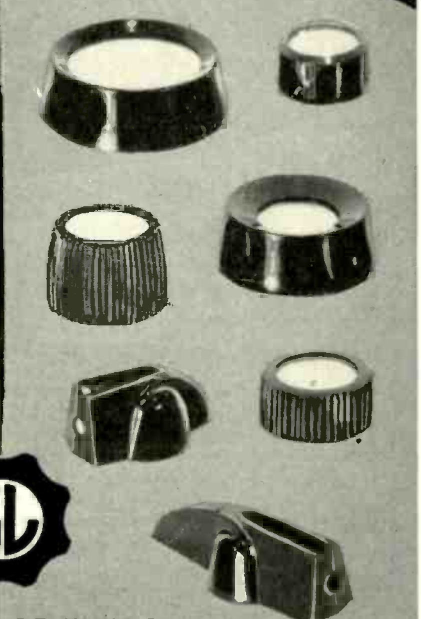

THE HOUSE OF KNOBS

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effect of grid-to-cathode spacing on tube characteristics is discussed. The general theory of multigrid receiving tubes is reviewed. A short section is devoted to transmitting-tube problems. A large portion of the tube section deals with high-frequency types such as velocity-modulated tubes, klystrons, magnetrons and traveling-wave tubes. The theory of each high-frequency type is discussed.

A portion of section three is devoted to triodes for ultrahigh frequencies. Plane-parallel constructions such as the lighthouse series are discussed. This section is not quite up to date in that the cylindrical construction used in such ultra-high frequency tubes as pencil-type triodes has been omitted. In addition to a review of uhf triodes, theoretical discussions of grounded-grid amplifiers and oscillators are presented. The electron behavior at uhf frequencies and its effect on tube characteristics are discussed. The concluding portion of the tube section is devoted to picture converters and storage tubes. The principles of the iconoscope, image iconoscope, orthicon, image orthicon, graphecon and barrier-grid storage tube are discussed.

This book clearly and concisely presents the basic theory of thermionic tubes and the design features of conventional receiving tubes. Those interested in electronics will find it basic. The book is well written and should prove useful to any tube engineer.— C. M. MORRIS, *Tube Division, Radio Corporation of America, Harrison, N. J.*

Introductory Circuit Theory

BY ERNST A. GUILLEMIN. *John Wiley and Sons, Inc., New York,* 1953, 550 *pages,* $8.50.

THIS IS a very difficult book to review. It has many virtues, a thoroughly modern point of view, and as far as "linear, passive, lumped, finite, bilateral circuit theory" is concerned, is a complete and exhaustive treatment.

It is "intended to be an introductory course in circuit theory" and is taught to sophomores in both

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physics and electrical engineering.

The first three chapters represent a quite elaborate discussion of d-c circuits in 188 pages and serve to lay a philosophical or geometric basis for network analysis. Chapter 3 introduces the use of determinants and works out the basic transformation and reciprocity theorems, including a study of invariance for resistance networks.

Chapters 4 to 8 are intended as a possible one-semester course on linear circuit theory, including transients. Chapters 4 and 5 introduce the volt-ampere relations for inductance and capacitance elements, largely in terms of the unit step and impulse functions, including generalization of some of the basic network theorems. Chapter 6 studies the behavior of simple circuits in the sinusoidal steady state, including an initial discussion of the complex frequency plane. Chapter 7 discusses the energy and power relations in such simple circuits. The final chapter (8) in this group generalizes the sinusoidal steady-state condition for more general passive networks. It introduces the concept of mutual inductance and the analysis of polyphase networks.

For students able to take a full-year course, it is recommended that some of the material be transferred to the semester in which Chapters 1 to 3 are studied and that Chapter 9 be added to complete the year's work. In this chapter, the subject of transient response is generalized, and the complete solution for any finite lumped network is developed. Here the concept of complex frequency is fully developed and frequency and time domains are introduced and illustrated by means of numerous interesting examples.

Even for a full year's course the author suggests that "Chapter 10, which rounds off and generalizes some of the previous discussion, remains as a collateral reading assignment, or as a reminder that the study of circuit theory has no ending". This chapter "supplies a certain generality and completeness to the derivation of the general equilibrium equations and energy relations".

The examples are numerous and well chosen. The book is profusely

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illustrated. The index is adequate. The format is clear and easily read.

The main complaint of this reviewer is that such an exhaustive introduction to circuit theory tends also to be exhausting. If, as seems necessary to cope with the expanding technology, it is going to be necessary to teach the fundamental theories at an earlier age, it would seem to be an obligation on the part of an author to be selective both in what he presents to the student and in how he presents it. Hard writing makes easy reading, and over-elaboration in material dilutes comprehension. To such comment as the last, Professor Guillemin replies: "In answer to such comment I can only say that. . . . I could see no point in deliberately stopping before I had finished what I had to say and what I consider to be a minimum of necessary material to form a good background on which to build later". The first result of this frame of mind is a preface fifteen pages long.

The next serious complaint is a carelessness of subscript notation throughout the book which will force the student to unlearn much when he undertakes the study of active networks. While it may be satisfactory to define

$$Z\ 12\ (s) = E_1/I_2 \qquad (109$$

in one equation and

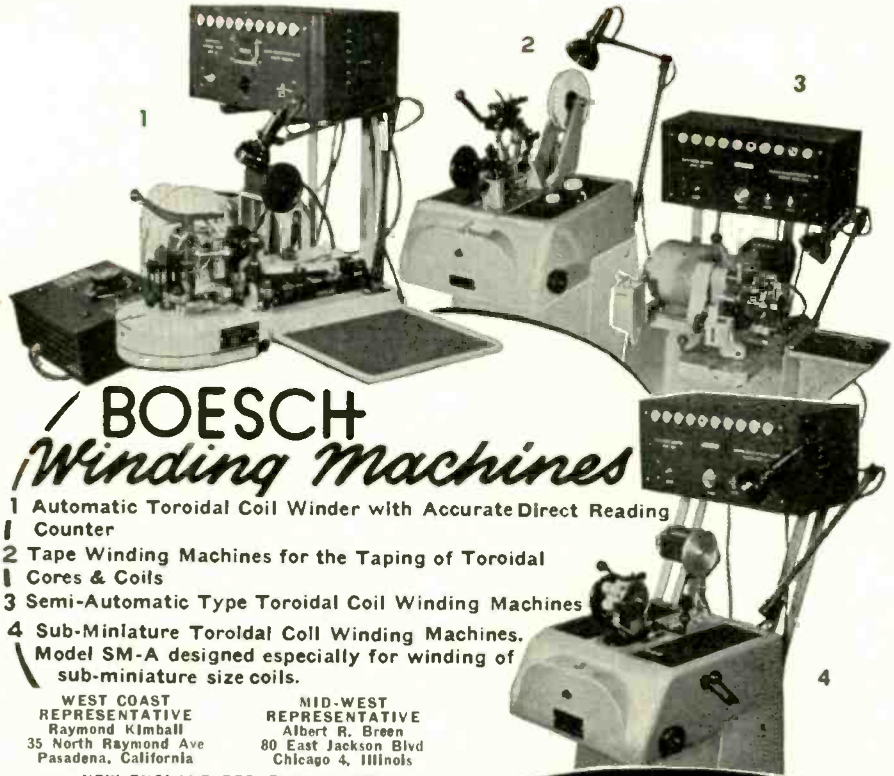
$$Z\ 12\ (s) = E_2/I_2 \qquad (163)$$

in another, this reversal will quickly bring one to grief in an analysis of an active nonlinear network.

This second flaw could be readily cured by careful editing, but I fear that the first one would require a completely new approach. It is highly desirable that at long last someone write a simple, straightforward, closely written introduction to modern circuit theory. Unfortunately, this book, which is in many ways so excellent, is not it.—KNOX MCILWAIN, *Hazeltine Electronics Corp.*

THUMBNAIL REVIEWS

Materials and Processes. By James F. Young. John Wiley & Sons, Inc., New York, Second Edition, 1954, 1074 pages, $8.50. Expanded coverage of



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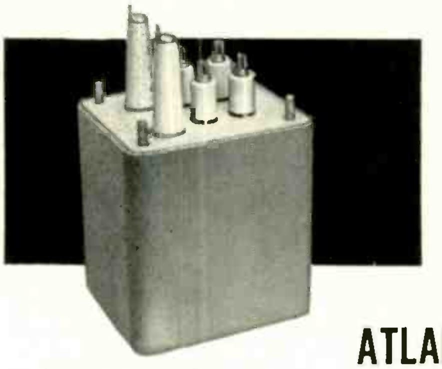

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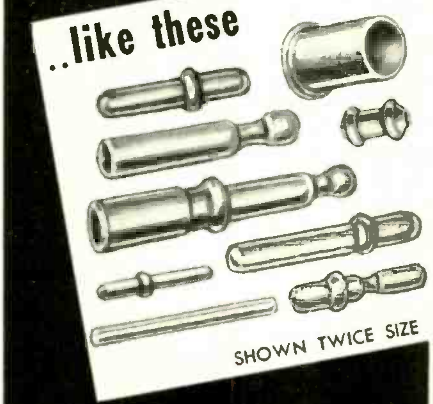

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Receiving Tube Substitution Guide Book. By H. A. Middleton. John F. Rider Publisher, Inc., New York, Second Supplement, 1954, 48 pages, $.99. Television receiving tube substitutions, including picture tubes; many are applicable to industrial electronic equipment and communication equipment.

Introduction to Color TV. By M. Kaufman and H. Thomas. John F. Rider Publisher, Inc., New York, 1954, 140 pages, $2.10. Basic principles and basic circuits, for engineers not now familiar with color television processes.

History of American Industrial Science. By Courtney R. Hall. Library Publishers, New York, 1954, 453 pages, $4.95. Includes one 34-page chapter on The Electrical and Communications Industries, summarizing major developments.

Six-Figure Mathematical Tables. By L. J. Comrie. Chemical Publishing Co., Inc., Brooklyn, New York, 387 pages, 1954, $6.50. Trigonometrical functions and logarithms thereof, circular functions, exponential and hyperbolic functions.

UHF Conversion, Installation, Service. Westinghouse Electric Corp., 36 pages, 1954, $1.00. Antennas and lines, conversion data, graphs and charts. For the service man and anyone wanting medium-technical material.

UHF TELEVISION WITH SECTION ON VHF TUNERS. By Edward M. Noll. Paul H. Wendel Publishing Co., P. O. Box 1321, Indianapolis; 72 pages, 1953, $1.00. Practical technical data on vhf-uhf tuners, uhf antenna performance, uhf propagation characteristics and uhf converters. A nicely arranged, well illustrated large-format book for the serviceman.

Television and Radar Encyclopedia. Edited by W. MacLanachan. Pitman Publishing Corp., New York, N. Y., 1953, 216 pages, $6.00. Definitions of terms in common use in Great Britain and U. S., including new coined words that may or may not pass into the recognized terminology of television and radar. Primarily intended for technicians and laymen, but contains sufficient data to have reference value for engineers as well.

Electric Control Systems. By Richard W. Jones. John Wiley & Sons, Inc., Third Edition, 511 pages, 1953, $7.75. For senior college students. Motor control systems of all types, with excellent chapters on gaseous electronic switching devices, electronic switching circuits and power amplifiers of the dynamoelectric and magnetic amplifier types.

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BACKTALK

Silicon vs Germanium

DEAR SIRS:

I SHOULD like to call your attention to two statements which appear in the article titled, "Silicon Invades Junction Diode Market", on page 12 of May ELECTRONICS.

First, you state that "silicon diodes do everything that germanium diodes do and do it better." Actually, recovery time and cut-off frequency for comparable d-c characteristics are poorer in silicon than in germanium. Furthermore, the very low carrier mobilities in silicon appear to be a fundamental obstacle to further improvement in the characteristics of silicon devices.

Second, you state that "germanium diodes tend to break down under ambient temperatures between 65 and 75 C." You may be interested in learning that we have made germanium point-contact diodes which have over 200,000 ohms back resistance at 100 C, and over 50,000 ohms at 125 C. Also, we can manufacture these diodes with sufficient control so as to be able to sell them at prices only slightly higher than ordinary germanium diodes.

Your article does not refer to point-contact diodes by name and does, in fact, use the term "junction diodes" in the title, but in the text the all-inclusive term "germanium diodes" is used; hence this letter.

L. S. PELFREY
Manager
Germanium Division
International Rectifier Corp.
El Segundo, California

(Editor's Note: We agree, we did mean junction diodes, but are glad to present data on improved point-contact germanium diodes at this time.)

Teacher Speaks

DEAR SIRS:

SINCE I am responsible for the conduct of a very large operation in undergraduate electronic engineering education and currently searching the country for "qualified" engineering teachers, I would like to comment on your current teacher vs engineer discussions.

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picture. Mr. McMurtrey, in the May issue *Backtalk* column, states that his colleagues are making from 2 to 4 times their former annual teaching salaries. Average teaching salaries amongst my colleagues are around $500 per month, payable for 12 months, for nine months of resident work. Our scale is neither the highest nor the lowest in engineering colleges.

From this I have to conclude (very unscientifically) that Mr. McMurtrey and his colleagues are earning from 12,000 to 24,000 dollars a year, with the usual two-week vacation. (That doesn't give much time to spend this dough.) I am sure the readers (engineers and teachers) of ELECTRONICS are able to judge the accuracy of this claim.

I believe the old engineering adage "salary is secondary" plays a more important role in this matter than most of us are willing to admit. Having spent an equal number of years in industry and teaching, I find that teaching is harder if you want to really do something about it. Both teachers and colleges (vs industry) tend to idealize every situation. One of the results has been some arbitrary hiring requirements which have chased some good men away from teaching. We are being forced to be more realistic in this matter.

C. RADIUS
Head of Dept., Electronic Engineering
California State Polytechnic College
San Luis Obispo, California

(Editor's Note: Welcome to the discussion. Further comments are invited from engineers and teachers on any of the various factors involved, such as money, job satisfaction, achievements, surroundings, social aspects, and so on.)

Range Control

DEAR SIRS:

WE HERE at Victory Engineering Corporation have come to look upon ELECTRONICS as the leading technical magazine in the electronics field.

In your March, 1954 issue, on page 12, under the heading "Industry Report" we note the following:

"Range-top thermostats that use a phototube to sense pan temperature and avoid scorching food were introduced last year on Westinghouse's top model electric range. The device is available this year on both double and single-oven models in the premium line."

This statement by your own good selves happens to be entirely erroneous since neither a thermostat or a phototube are utilized in the Westinghouse range to sense pan temperature and avoid scorching the food. The sensing element utilized is a thermistor, and we are proud to state that the thermistors used in this connection were a development of our Engineering Department in connection with Westinghouse engineers and are VECO thermistors.

B. J. OPPENHEIM
General Manager
Victory Engineering Corporation
Union, New Jersey

(Editor's note): First mention of the sensing element in ELECTRONICS (Industry Report, p 18, April, 1953) identified it as a thermistor but the editors were misled by recent news stories which stated that the Westinghouse range line featured "a new automatic Corox with Electronic Eye surface unit on Commander double-oven range . . . Electronic eye unit measures temperature of food cooking in pan and maintains it automatically by turning current off and on as needed . . .Electronic Eye unit holds deep fat frying temperature."

Transistor Amplifier

DEAR SIRS:

READING the article "High Frequency Transistor Amplifier" by W. F. Chow in April, 1954, ELECTRONICS (p 142), I encountered Eq. 11 which expresses the conditions for maximum power transfer from one amplifier stage to the next one.

I should like to point out that this condition is not correct, and that it should be

$$g_i' = g_o'$$

as can be seen from the following. It will also be demonstrated that more favorable conditions than those indicated by Eq. 12 can be achieved.

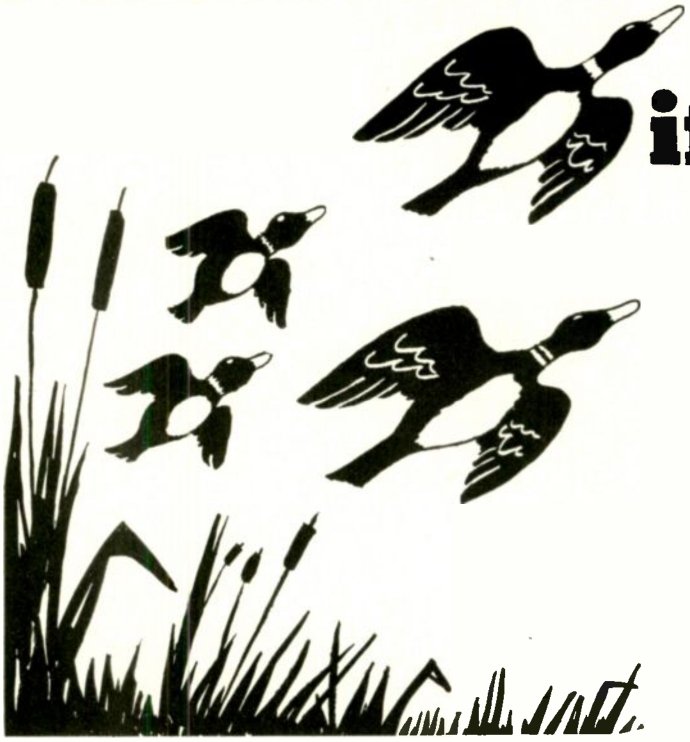
Using the notations of the paper

$$Q = \frac{\omega_o C'}{g_o' + g_l + g_i'} \qquad (13)$$

$$\text{and } Q_o = \frac{\omega_o C}{g_l} \cong \frac{\omega_o C'}{g_l} \qquad (14)$$

Now the power supplied to the load g_i' is

$$P_o = \frac{i'^2}{(g_o' + g_l + g_i')^2}\, g_i'$$



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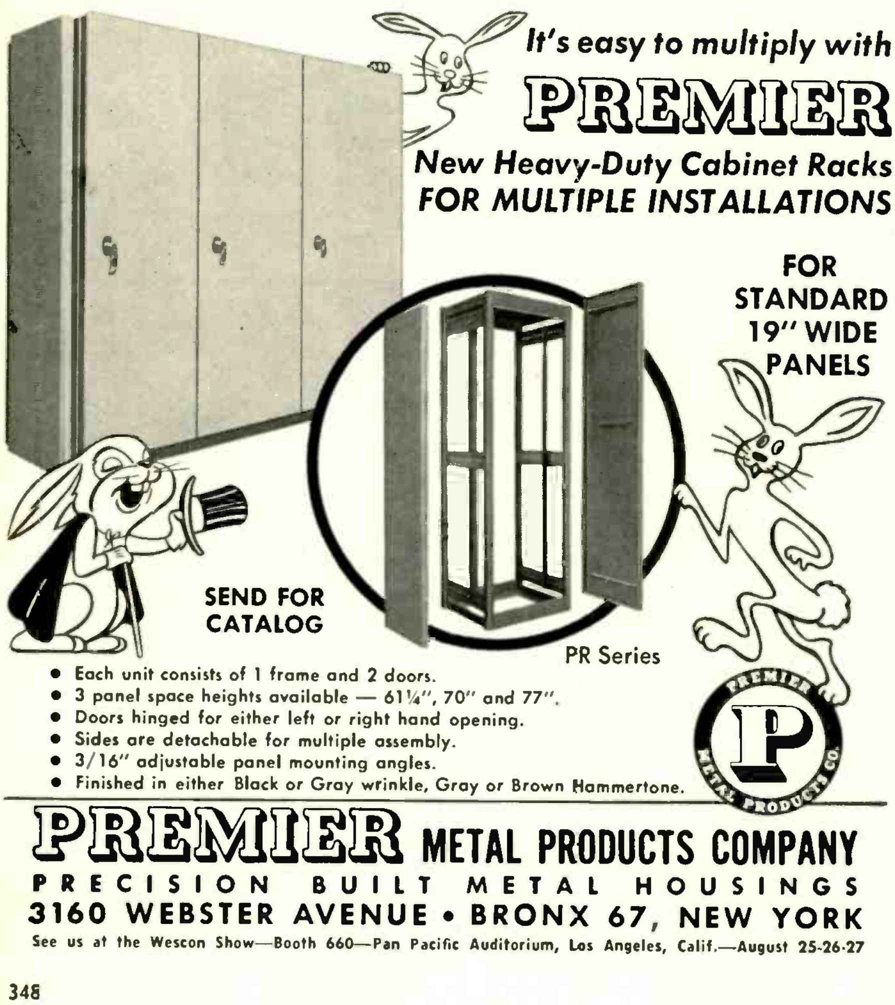

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$$= \frac{i'^2}{4g_o'} \quad \frac{4g_o' g_i'}{(go' + g_l + g_i')^2}$$

$$= \frac{i'^2}{4g_o'} \quad \frac{4g_o' g_i' Q^2}{\omega_o^2 C'^2}$$

in view of Eq. 12.

As $\frac{i'^2}{4g_o'}$ = Power available = P_{av}

$$P_o = P_{av} \frac{4Q^2}{\omega_o^2 C'^2} go' g_i' \qquad (1)$$

For a given Q

$$g_o' + g_i' = \text{constant} \qquad (2)$$

The constancy of Q and the condition expressed by Eq. 2 will make P_o maximum when

$$g_o' = g_i' \qquad (3)$$

as stated previously.
from Eq. 13, 14 and the writer's Eq. 3,

$$\frac{1}{Q} - \frac{1}{Q_o} = \frac{2g_o'}{\omega_o C'}$$

$$g_o' = g_i' = \frac{\omega_o C'}{2} \left(\frac{1}{Q} - \frac{1}{Q_o} \right)$$

$$= \frac{C'}{2} (\Delta\omega - \Delta\omega_o) \qquad (4)$$

substituting Eq. 4 into Eq. 1,

$$P_o = P_{av} \left(\frac{Q_o - Q}{Q_o} \right)^2 \qquad (5)$$

Therefore the loss factor

$$F_p{}^* = \left(\frac{Q_o - Q}{Q_o} \right)^2 \qquad (6)$$

I call the loss factor $F_p{}^*$ to distinguish it from that in Eq. 12 in the article.

Using the author's Eq. 11, 12, 13 and 14,

$$F_p = \frac{Q_o - 2Q}{Q_o} \qquad (7)$$

and $\frac{Fp^*}{F_p} \quad \frac{(Q_o - Q)^2}{Q_o (Q_o - 2Q)}$

$$= 1 + \frac{Q^2}{Q_o (Q_o - 2Q)} \qquad (8)$$

If Q has a value permitted by Eq. 11,

$$F_p{}^* > F_p$$

In my opinion the expression "loss factor" is unfortunate, since it increases with decreasing loss.

I should like to point out that if the circuit is designed according to the paper the Q of the circuit cannot be greater than $Q_o/2$; but if the above outlined procedure is followed Q can have any value up to Q_o.

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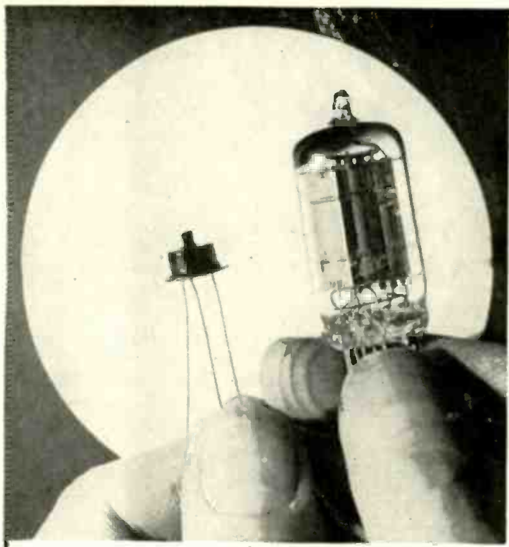

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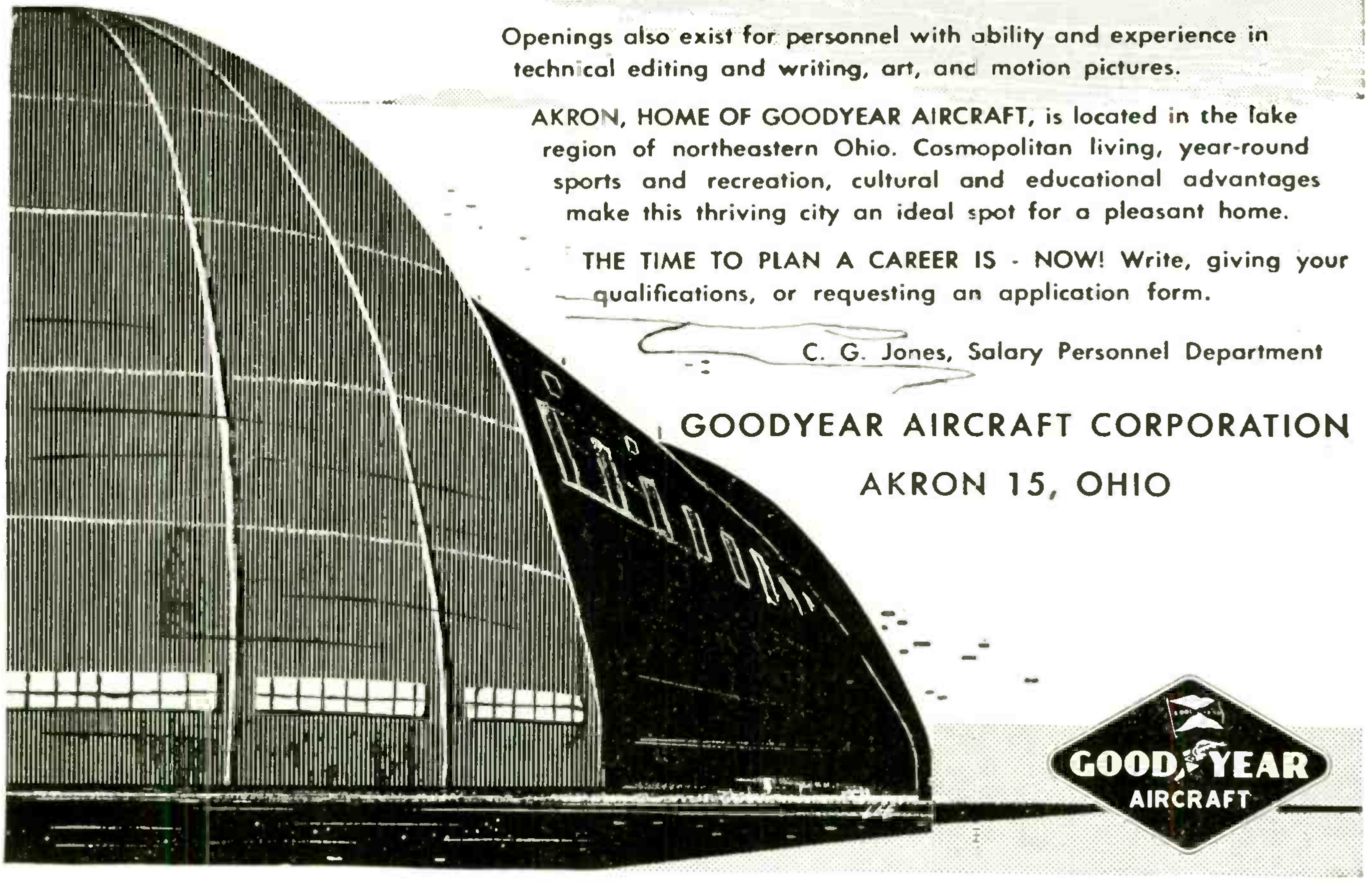

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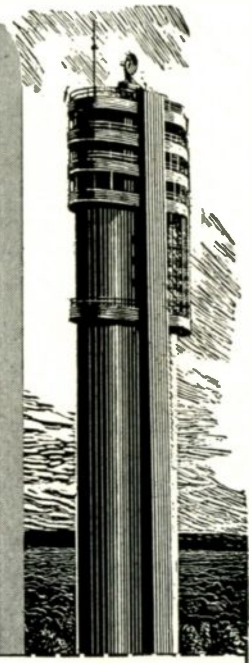

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TUNG-SOL ELECTRIC INC.
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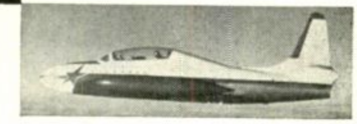
FX-104



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Aerodynamicists
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ENGINEERS

SYSTEMS
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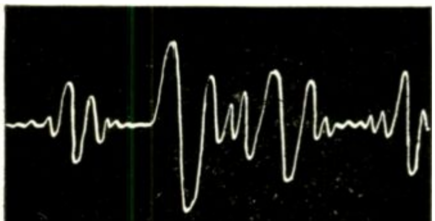

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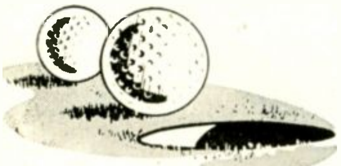

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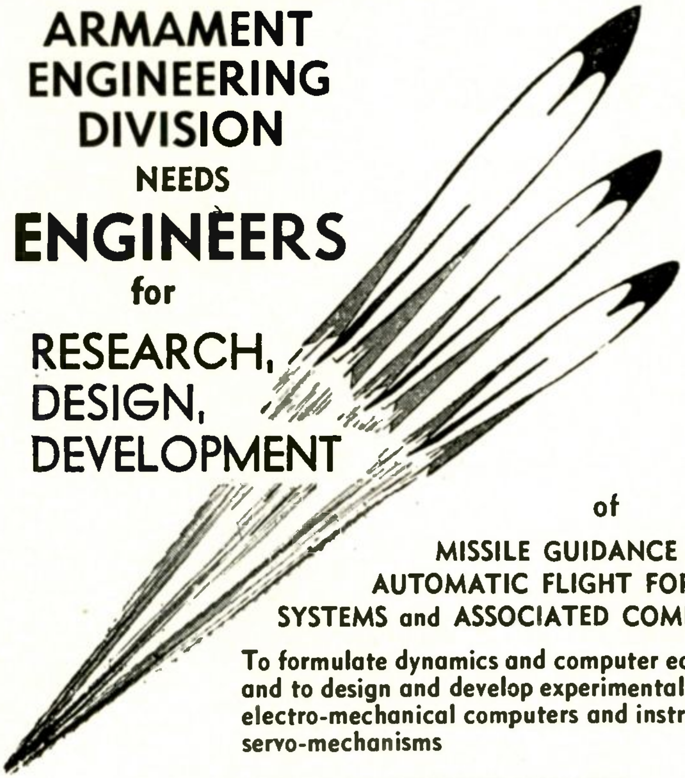

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K. High voltage power supply and CRT display circuits
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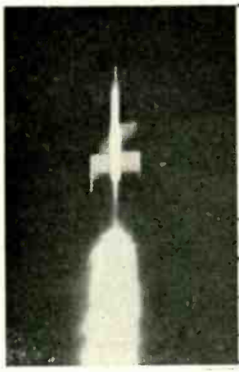

L. R. Osgood Dept. E-M-7
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Dear Sir: Please send me information on the Missile Systems Division.

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Diehl Type FJE-43-9 (Single Phase Rotor). Two stator windings 90° apart, provides two output sequel to the sine and cosine of the angular rotor displacement. Input voltage 115 volts, 400 cycle..........$30.00 ea.
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A.C. GENERATOR: 67 V., 20 Cyc., 2-Phase, .015 Amps. Type PM-1, 1200 R.P.M...............$15.00

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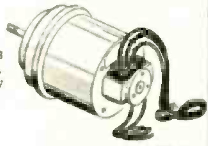

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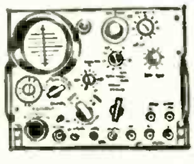
Model AN/APA-10



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Mfg. Carter Motor Co.; OUTPUT: 7 VAC; 9.7 amp.; 650 cycles, and 295 VDC. 200 amps. INPUT: 26.5 VDC; 10.5 amps; 6500 rpm...............$49.50 ea.

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10486 LELAND ELECTRIC

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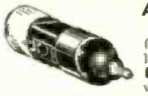
HAZELTINE PULSE GENERATOR

MODEL 1017

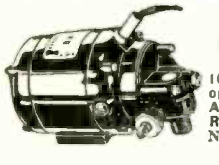
Electrical Characteristics: Pulse Freq: initiating and sliding pulse-external. Pulse Width: initiating and sliding pulses, 10 microseconds. Pulse Amplitude: initiating and sliding pulses, plus 150 volts. Sliding Pulse Delay: variable over full trace length. Sweep Duration: 50, 200, and 1000 microseconds. TUBES: 16-6SJ7; 3-6AG7; 3-6L6; 2-6J5 gt; 2-6SN7 gt; 1-5U4 G; 1-6SK7; 1-6Y6G; 1-991; 1-9002. Power input: 110-125 volts, 60 cyc. single phase; batteries none. Dimensions: 13½" x 20⅛" x 23". Weight 85 lbs. PRICE $79.50

ALNICO FIELD MOTORS



(Approx. size overall . . . 3¾" x 1¼" diameter)
DELCO TYPE #5069600: 27.5 volts DC: 250 RPM........$15.00
DELCO #5069230: 27.5 VDC: 145 rpm........$15.00
PM Motors Delco Type #5069371: 27.5 volts: DC Alnico Field: 10,000 R.P.M.; dimensions 1" x 1" x 2" long: shaft extension ½" diameter 0.125" $8.00

BODINE GEAR HEAD MOTORS



10.1 Gear Ratio: Motor operates: 24 VDC, 2 Amps, 1/50th H.P., 5000 RPM.
NEW $9.95

400 CYCLE MOTORS

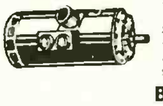
EASTERN AIR DEVICES #133 Synchronous Motor 115 Volt; 400 cycle.............................$17.50
PIONEER TYPE CK5 2 Phase; 400 cycles..$25.00 ea.
EASTERN AIR DEVICES TYPE J49A: 115 V; 0.1A; 7000 r.p.m. Single phase 400 cycle.........$17.50 ea.
AIRESEARCH: 115V; 400 CPS; Single phase 6500 RPM; 1.4 amp; Torque 4.6 in. oz.; HP. .03. $10.00 ea.
EASTERN AIR DEVICES TYPE JM6B: 200 VAC; 1 amp; 3 phase; 400 cycles, 6000 RPM....$12.50 ea.
EASTERN AIR DEVICES, TYPE J31B: 115 V. 400 1200 Cycle. Single Phase....................$12.50 ea.
AIRESEARCH: AC induction, 200 V; 3 Phase, 400 Cycle, 2 H.P.; 11,000 RPM; 8 amps........$79.50 ea.
AIRESEARCH: AC Induction, 200 V; 3 Phase, 400 Cycle, 12 H.P. 6500 RPM; 1.5 amps..........$25.00
Electric Motor: PNT—1400—A1—1A Serial No. 207, 208 V., 400 Cycles, 3 Phase Kearfott Co., Inc. $17.50 ea.

SERVO MOTOR 10047-2-A; 2 Phase; 400 Cycle, with 40-1 Reduction Gear $17.50

SMALL DC MOTORS

GENERAL ELECTRIC #5BA10AJ18 . . . 27 VDC: RPM 110; 1 oz. FT................................$12.50
DELCO #5069625 . . . 27 VDC: 120 RPM; Governor controlled $22.50
EMERSON 175: 12 Volt DC; 1/6th HP; 10 amp; 3800 RPM; Approx. size: 2½" x 5"..........$9.95 ea.
DELCO #5068750: 27 VDC; 160 RPM; built-in reduction gears ....$12.50 ea.
J. OSTER: series reversible motor 1/50th H.P.; 10,000 RPM: 27½ VDC; 2 amps; **SPERRY** #806059: approx. size 1⅝" x 3½"......................$7.00 ea.
General Electric Type 5AB10AJ37: 27 volts, DC; 5 amps. 8 oz. inches torque; 250 RPM, shunt wound; 4 leads; reversible $12.50
General Electric. Mod. 5BA10FJ33: 12 oz. inches torque. 12 DC 56 RPM. 1.02 amp..........$15.00 ea.
General Electric Type 5BA10AJ52C: 27 volts DC; 5 amps. 8 oz. inches torque; 145 RPM; shunt wound; 4 leads; reversible..............................$12.50
GENERAL ELECTRIC DC MOTOR Mod. 5BA10AJ-64, 160 r.p.m.; 65 amp; 12-oz.-in. torque 27V DC. $12.50
2¼ H.P. MOTOR—Mfg. LEECE-NEVILLE Co; Type 1454-MO: 24VDC: 4000 RPM; 100 amp.......$35.00

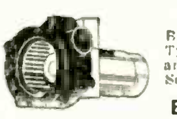
115 VOLT GENERATORS



Band new Eclipse generators; 115 VAC; 9.4 amp; 1000 watts; single phase; 800 cycles, 2400-4200 rpm. DC output is 30 volts at 25 amp. Unit has spline drive shaft and is self-excited.$29.95

BLOWER

Eastern Air Devices, Type J31B: 115 volt; 400-1200 Cycle; single phase; variable frequency; continuous duty, L. & R. #2 blower; approx. 22 cu. ft./min. $15.00



BLOWER: Mfg. John Oster; Type C2A-1B; 27 VDC; 63 amps; 1/100 H.P.; 7000 RPM; Series Wound ....$9.95 ea.

BLOWER ASSEMBLY

115 Volt, 400 Cycle, Westinghouse Type FL. 17CFM, complete with capacitor. New.............$9.95 ea.

TEST EQUIPMENT

TS 13/AP	$650.00
TS 35/UP	495.00
TS 45/APM	195.00
TS 51/APG	95.00
TS 59	69.50
TS 61/AP	69.50
TS 76/APM	79.50
TS 80/U	14.95
I-96-A	195.00
TS 251	650.00
LZ Signal Generator	149.00

C & H SALES CO

2176 East Colorado Street • Pasadena 8, California • RYan 1-7393

AMPLIFIER UNIT Magnetic

Mfr. Pioneer Instrument Type 12071-1-A; 110 volts, 400 cycles; 26 volts, 400 cycles; 4 tube (12AH7-GT); take-off for four autosyns . . .

$29.95 ea.

REMOTE INDICATOR

Mfr. PIONEER, Type A100-1E; 360° directional dial; 26 volts; 400 cycle; 3" dia. dial; contains AY 34 Autosyn.

$4.95

PIONEER TORQUE UNITS

Type 12602-1-A. Includes CK 5 motor coupled to output shaft thru 125:1 gear reduction train. Output shaft coupled to autosyn follow-up (AY-43). Ratio of output shaft to follow-up autosyn is 30:1. Includes base mounting type cover for motor and gear train . . .

$34.95 ea.

TREMENDOUS SAVINGS IN ELECTRONIC WAR TERMINATION INVENTORIES

SAVE UP TO 85% • IMMEDIATE DELIVERY • EQUIPMENT FULLY GUARANTEED

MOTOR

Mfg. Barber-Colman Co.; shaded pole; 1500 RPM; shaft ⅛" x ⅝"; overall size 1½" x 2¼" x 2⅝"; includes mounting bracket . . .

$1.50 ea.

SYNCHRO TRANSMITTERS

Mfr. Kearfott; Type R-212-1A-A; ROTOR — 1 phase, 26 volts. STATOR — 3 phase, 11.8 volts, 400 cycle. Overall size: 1-1/16" dia. x 1-11/16" long shaft 3/16" long; includes mounting bracket . . .

$19.95 ea.

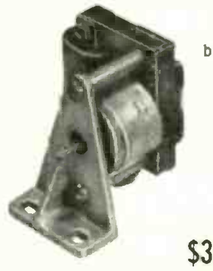
TIME DELAY RELAY

Delay action is accomplished by a Telechron motor with a mechanism calibrated in 15 sec. steps, and adjustable from 15 sec. to 5 min. Timer contacts are S.P.D.T. and rated at 12 amps. **Instantaneous Recycling.** 115 VAC coil operation . . .

$7.95 ea.

TELECHRON SYNCHRONOUS MOTOR

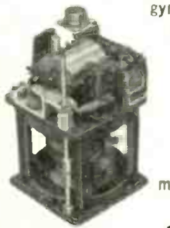
Type 3C; 110 Volt; 60 Cycle; 60 RPM; with mounting bracket . . .



$3.95 ea.

SCHWEIN REMOTE CONTROL DUAL GYRO

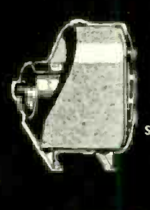
Type 45600 Free & Rate Gyro. Contains two 28 VDC constant speed gyros . . . vertical and horizontal. Both gyros exceed 30,000 RPM. Size: 8" x 4½" x 4½". Complete with metal cover . . .



$22.50 ea.

HIGH PRESSURE TURBO-COMPRESSORS

12 cfm at 35 oz.; ¾ HP, AC/DC; 115 volts; 25 to 60 cycles. No. BL12SP . . . Powered by Black and Decker AC/DC, ball-bearing, cont. duty, int. fan cooled, high speed, single phase motors . . .



$49.50 ea.

SYNCHRON TIMER

Model 600; 4 RPM; 110 Volt AC; 60 Cycle . . .

$2.20 ea.

AUTOSYN MOTORS

Mfr. Bendix Type 851; 32 volts AC; 60 cycle; single phase; Size: 3¼" l. x 2⅝" dia. ⅛" shaft . . .

$19.95 pr.

WRITE OR WIRE FOR INFORMATION ON OUR COMPLETE LINE OF SURPLUS ELECTRONIC COMPONENTS. ALL PRICES NET F. O. B. PASADENA, CALIFORNIA.

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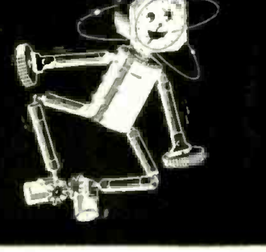

MINIATURIZED SELSYN

Mfr. Henschel Corp.; 115 volts; 60 cycle; .22 amp. Type "N" Indicator Motor with dampener. Brass encased. Approx. size: 2¼" dia. x 3½" length . . .

$19.95 pr.

PRECISION PLANETARY DIFFERENTIAL

1:1 reverse ratio, ring gear 3" dia., 120 teeth. Overall length 5¼". shaft dia. 11/32", ⅛" key on one end. Shaft length on keyed end ¾", ⅝" on other end. Gear on ring 1-11/32", 52 teeth. Shaft ends have ¼-28 threads. Construction principally brass . . .

$4.95 ea.

VARIABLE SPEED DRIVE

Mfr. Western Elec. Type 3717 Ball Integrator Model. Forward and Reverse; Input Shaft, 23/32" long x 5/16" dia. Output shaft, 23/32" long x 3/16" dia. Speed Control Shaft, 23/32" long x 11/64" dia. Torque adjustment. Approx. size: 5" x 5" x 2½". Brass construction.

$17.50

COMMUNICATIONS EQUIPMENT CO.

MICROWAVE COMPONENTS

10 CM.—RG48/U Waveguide

10 CM ECHO BOX: Tunable from 3200-3333 Mc. For checking out radar transmitters, for spectrum analysis, etc. Complete with pickup antenna and coupling devices. $27.50

10 CM ANTENNA ASSEMBLY: 3000-3300 Mc. Parabolic Dish. 29 inch Diam. Fed from dipole Rotation: 360 Deg. Azimuth at speeds of 20 and 10 RPM. Tilt: 20 deg. above and below horizontal. Motor-Driven by 2-28V motors. 4.5 A Total Drain. Azimuth info. is fed to selsyn mechanism, and elevation data is obtained from Azimuth potentiometer. Net weight 65 lbs. $78.50

POWER SPLITTER for use with type 726 or any 10 CM Shepherd Klystron. Energy is fed from Klystron antenna through dual pick-up system to 2 type "N" output connectors .... $22.50 EACH

DIRECTIONAL COUPLER. Broadband type "N" Coupling, 20 db, with std flanges, Navy #CABV47A-AN-2 .... $32.50

LHTR. LIGHTHOUSE ASSEMBLY. Parts of RT39 APG 5 & APG 15, Receiver and Trans. Cavities w/assoc. Tr. Cavity and Type N CPLG, To Recvr. Uses 2C40, 2C43, 1B27. Tunable APX 2400-2700 MCS. Silver Plated $22.50

BEACON LIGHTHOUSE cavity p/o UPN-2 Beacon 10 cm. Mfg. Bernard Rice, each $27.50

MAGNETRON TO WAVEGUIDE Coupler with 721-A Duplexer Cavity, gold plated $45.00

721A TR BOX complete with tube and tuning plungers $12.50

McNALLY KLYSTRON CAVITIES for 707B or 2K28 2700-2900 MC $4.00

WAVEGUIDE to ⅞" Rigid Coax "Doorknor" Adapter Choke Flange Silver Plated Broad Band $32.50

AS14A AP-10 CM Pick up Dipole with "N" Cables $4.50

HOLMDELL-TO-TYPE "N" Male Adapters. W. E. #D167284 .... $2.75

I.F. AMP. STRIP: 30 MC, 30 d.b. gain, 4 MC Bandwidth, uses 6AC7's—less tubes $24.00

BEACON ANTENNA, AS31/APN-7 in Lucite Ball. Type "N" feed $22.50

ANTENNA, AT49A/APR: Broadband Conical, 300-3300 MC Type "N" Feed $12.50

"E" PLANE BENDS, 90 deg. less flanges $7.50

3 CM.—RG 52/U Waveguide

FLEX. WAVEGUIDE SECTION, 1 ft. long. Width UG-40/UG-39 flanges. Attenuation is less than 0.1 db. at 9375 mc. and VSWR is less than 1.02. Rubber covered $7.50

3 CM ANTENNA ASSEMBLY: Uses 17" paraboloid dish, operating from 24 vdc motor. Beam pattern: 5 deg. in both Azimuth and elevation. Sector Scan: over 160 deg. at 35 scans per minute Elevation Scan: over 2 deg. Tilt: over 24 deg. $85.00

Cross-Guide Directional Coupler, UG-40 output flange. Main Guide is 6" Long, with 90 Deg. "E" Plane bend at one end, and is fitted with Std. UG 39/UG 40 flanges. Coupling figure: 20 db Nominal ... $22.50

VSWR Measuring Section: Consisting of 6" straight section, with 2 pick-up, Type "N" Output Jacks, mounted ½ Wave apart $7.50

RG52/U Waveguide in 5' lengths, fitted with UG 39 flanges to UG40. Silver plated ...... **per length $5.00**

Rotating-joints supplied either with or without deck mounting. With UG40 flanges .... **each, $17.50**

Bulkhead Feed-thru Assembly $15.00

Pressure Gauge Section with 15 lb. gauge $10.00

Directional Coupler, UG-40/U Take off 20db $17.50

TR-ATR Duplexer section for above $8.50

Rotary joint choke to choke with deck mounting .. $17.50

90 degree elbows. "E" plane 2½" radius $12.50

Microwave Receiver, 3 CM. Sensitivity: 10-13μ Watts. Complete with L.O. and AFC Mixer and Waveguide Input Circuits, 6 I.F. Stages give approximately 120 DB. gain at a bandwidth of 1.7 MC. Video Bandwidth; 2 MC. Uses latest type AFC circuit. Complete with all tubes, including 723A/B Local Oscillator $175.00

ADAPTER, waveguide to type "N", UG 81/U, p/o TS 12, TS-13, Etc. $14.50

ADAPTER, UG-163/U round cover to special btl. Flange for TS-45, etc. .... $2.50 ea.

3CM Motor-Driven Echo Box

Cavity Q is 30,000. Tuning range 80 mc Motor operates from 24 VDC, Type "N" INPUT $32.50

1¼" x ⅝" WAVEGUIDE

VSWR SECTION. 6"L, with 2-type "N" pickups mounted ½ wave apart $7.50

GG 98B/APQ 13 12" Flex, Sect. 1¼" x ⅝" OD. .. $7.50

X Band Wave GD 1¼" x ⅝" O.D. 1/16" wall aluminum .... per ft. 75¢

Slug Tuner Attenuator W.E. guide, gold plated ... $6.50

Bi-Directional Coupler. Type "N" Takeoff 25 db. coupling $22.50

Bi-Directional Coupler. UG-52. Takeoff. 25 db. coupling $17.50

Waveguide-to-Type "N" Adapter. Broadband ... $17.50

CATHODE RAY TUBES

3FP7*	$1.50	5FP7*	$1.50
3EP1*	$2.50	*Mfrs. Quantity	

MAGNETRONS

Type	Freq. Range (MC)	Peak Power Out (KW)	Duty Ratio	Price
2J21A	3345–9405	50		$8.75
2J22	3267–3333	265		7.50
2J26	2992–3019	275	.002	7.49
2J27	2965–2992	275	.002	19.95
2J29	2914–2939	275	.002	44.95
2J31	2820–2860	285	.002	24.50
2J32	2780–2820	285	.002	28.50
2J38*	3249–3263	5		16.50
2J39*	3267–3333	8.7		24.50
2J48	9310–9320	50	.001	24.50
2J49	9000–9160	50	.001	59.50
2J56*	9215–9275	50	.001	132.50
2J61†	3000–3100	35	.002	34.50
2J62†	2914–3010	35	.002	34.50
3J31	24–27KMC	50	.001	85.00
4J34	2740–2780	900		125.00
4J38	3550–3600	750	.001	169.45
4J42†	670–730	30	.003	169.50
5J23	1044–1056	475	.001	49.00
700B	690–700	40	.002	22.50
700D	710–720	40	.002	39.75
706EY	3038–3069	200	.001	32.50
706CY	2976–3007	200	.001	32.50
725-A	9345–9405	50	.001	7.50
QK259	2700–2900	800	.001	249.50
QK60†*	2840–3005	.100	CW	85.00
QK61†*	2975–3170	.100	CW	85.00
QK62†*	3135–3350	.100	CW	85.00

*—Packaged with magnet.
†—Tunable over indicated range.

KLYSTRONS

723A	$12.50	2K25/723A/B	$27.50
723A/B	19.50	417-A	17.50

MOD. MCG BATTLE AMPLIFIER

Entire unit consists of 2 150-watt amplifiers mounted in a 7 ft. rack, together with tube check device, alarm signal generator, and distribution panel. Both amplifiers feature variable volume compression. Output stage consists of P-P parallel 809's. Used, but in excellent condition, complete with all tubes; operates from 115 v, 60 cy. 1 phase $350

10 CM R.F. HEAD

Complete R.F. Head and Modulator delivers 50 KW Peak R.F. at 3000 MC. Pulser delivers 12KV pulse at 12 Amp. to magnetron of .5, 1, or 2 microsec. duration at duty cycle of 001. Unit requires 115V, 400-2400 Cycles, 1 phase @ 3.5A. Also 24-28 VDC @ 2A. External sync. Pulse of 120V Reg'd. Brand New. Complete with schematic and all tubes $375.00

VARISTORS

D-167208	$1.35	D-171812	$1.63
D-171858	$1.42	D-172155	$1.50
D-168687	$1.35	D-167176	$1.25

THERMISTORS

D-164699 Bead Type DCR: 1525-2550 Ohms @ 75 Deg. F. Coefficient: 2% Per. Deg. Fahr. Max. Current 25 MA AC/DC $2.50

D-167332 Bead Type. DCR is 1525-2550 Ohms. Rated 25 MA at .825-1.175 VDC $1.35

D-167613 Disk Type DCR: 355 Ohms @ 75 Deg. F.P.M. 2.5%. 1 Watt $1.35

D-166228 Disk Type 7120 Ohms @ 60°F. 4220 Ohms @ 80°F. 2590 Ohms @ 100°F.. 1640 Ohms @ 120°F $1.35

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APA-9
APA-10
APN-3
APN-7
APN-9*
APS-2
APS-3
APS-4
APS-6
ASD
ASH
BG
DAS†
DBS†
APT-2
APT-4
MKIV
MKX
RC145
RC148
SO-1
SO-8
SG-1
SJ-1
TAJ
TBK
TBL
SCR520*
SCR521
SCR518

* COMPONENTS. † LORAN EQUIPMENT.

—TEST SETS—

TSX-4SE
TS-35A
TS-47
TS-12
TS-56
TS-34
TS-159
TS-968
TS-238

Sickles Model III Range Calibrator $365.00

TS 98A/AP Voltage Divided .... $ 75.00

TS 90 Dummy Load, 50 Ohms Impedance will handle 500 watts at peak of 5000 volts. Divider ratio 50:1 .... $145.00

TS 235/UP Dummy Antenna 500-1500 MC Impedance: 50 Ohms 1000 watts average power $225.00

JAN WAVEGUIDE FLANGES

UG 39/U	$1.10	UG 51/U	$1.65
UG 40/U	$1.25	UG 52/U	$3.40
UG 40A/U	$1.65	UG 52A/U	$3.40

PULSE TRANSFORMERS

Westinghouse 4P37: Primary: 50 ohms imp, 750 v. Sec. 15 kv, 1000 ohms imp. Bifilar filament trans. built-in, delivers 12.6 v at 2.5 amp. (pri. 115 v, 400 cy.) $37.50

RAYTHEON WX 4298E: Primary 4KV., 1.0 USEC. SEC: 16KV-16 AMP DUTY RATIO: .001 400 CYCLE FIL. TRANS. "BUILT-IN" $42.50

WECO: KS 9948: Primary 700 ohms; Sec. 50 ohms. Plate Voltage: 18 KV. Part of APQ-13 .... $12.50

GE #K-2449A

Primary: 9.33 KV, 50 ohms Imp.
Secondary: 28 KV, 450 ohms.
Pulse length: 1.0/5 usec @ 635/120 PPS. Pk Power Out: 1,740 KW
Bifilar: 1.5 amps. (as shown) .. $62.50

GE #K2748-A. 0.5 usec @ 2000 Pps. Pk. Pwr. out is 32 KW impedance 40:100 ohm output. Pri. volts 2.3 KV Pk. Sec. volts 11.5 KV Pk. Bifilar rated at 1.3 Amp. Fitted with magnetron well $39.50

K-2745 Primary: 3.1/2.8 KV, 50 ohms Z. Secondary: 14/12.6 KV 1025 ohms Z. Pulse Length: 0.25/1.0 usec @ 600/600 PPS. Pk. Power 200/150 KW. Bifilar: 1.3 Amp. Has "built-in" magnetron well $42.50

K-2461-A. Primary: 3.1/2.6 KV—50 ohms (line). Secondary 14/11.5 KV—1000 ohms Z. Pulse Length: 1 usec @ 600 PPS. Pk. Power Out: 200/130 KW. Bifilar: 1.3 Amp. Fitted with magnetron well .. $39.75

UTAH X-151T-1: Dual Transformer, 2 Wdgs. per section 1:1 Ratio per sec 13 MH inductance 30 ohms DCR $5.00

UTAH X-150T-1: Two sections, 3 Wdgs. per section. 1:1:1 Ratio, 3 MH, 6 ohms DCR per Wdg $5.00

68G711: Ratio: 4:1 Pri: 200V, Sec. 53V, 1.0 usec Pulse @ 2000 PPS, 0.016 KVA $4.50

TR1049 Ratio 2:1 Pri. 220 MH, 50 Ohms, sec. 0.75 H. DCR 100 Ohms $6.75

K-904695-501: Ratio 1:1. Pri. Imp. 40 Ohm, Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 0.05 usec rise $8.95

Ray UX 7896—Pulse Output Pri. 5v sec. 41v $7.50

Ray UX 8442—Pulse inversion—40v + 40v $7.50

PHILCO 352-7250, 352-7251, 352-7287

RAYTHEON: UX8693, UX5986, UX-7307 .... $5 ea.

W.E.: D-166310, D-166638, KS9800, D-163247.

UTAH #9262, with Cracked Beads, but will operate at full rated capacity $5.00

UX 8693 (SCS #2Z9627-54): 3 Wdgs. 32 turns #18 wire. DCR is: 362/.372/.4 ohms. Total voltage 2500 vdc. $5.00

D-166173: Input: 50 ohms Z. Output: 900 ohms 3 Wdgs. Freq. range 10 kc-2mc. P/O AN/APQ*-13 .... $12.50

K-2450: Pulse-inversion auto-transformer: primary 13 kv, 4 usec. Output: 14 kv @ 100 kw peak $34.50

PULSE NETWORKS

15A—1-400-50; 15 KV, "A" CKT, 1 microsec. 400 PPS. 50 ohms imp. $37.50

G.E. #3E (3-84-810) (8-2.24-405) 50P4T; 3 KV "E" CKT Dual Unit: Unit 1, 3 sections, 0.84 Microsec. 810 PPS. 50 ohms imp: Unit 2, 8 Sections, 2.24 microsec. 405 PPS 50 ohms imp. $6.50

7-5E3-1-200-67P, 7.5 KV "E" Circuit, 1 microsec. 200 PPS, 67 ohms impedance 3 sections $7.50

7-5E4-16-60, 67P, 7.5 KV "E" Circuit, 4 sections 16 microsec. 60 PPS, 67 ohms impedance $15.00

7-5E3-3-200-67P. 7.5 KV, "E" Circuit, 3 microsec. 200 PPs, ohms imp, 3 sections $12.50

H-616 10KV. 2.2 usec., 375 PPS. 50 ohms imp. .$27.50

H-615 10KV. 0.85 usec., 750 PPS. 50 ohms imp. .$27.50

KS8865 CHARGING CHOKE: 115-150 H @ .02A, 32—40H @ .08A, 21KV Test $37.50

G.E. 25E5-1-350-50 P2T, "E" CKT, 1 Microsec. Pulse @ 350 PPS, 50 OHMS Impedance $69.50

KS9623 CHARGING CHOKE: 16H @ 75 MA, 380 Ohms DCR. 9000 Vac test $14.95

G.E. 6E3-.5-2000 50 P2T: 6 KV., "E" Circuit 0.5 usec /2000 PPS/50 ohms/2 sections $7.50

PULSE EQUIPMENT

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp.) Duty Ratio; .001 max. Pulse duration: 5. 1.0, 2.0 microsec, Input voltage: 115 v, 400 to 2400 cps. Uses: 1-71B, 4-89-B, 3-'72's, 1-'73. New .... Less Cover—$135

ASD Modulator Units, mfd. by Sperry. Hard tube pulser delivers Pk. pulse of 144 kw. Similar to Mod 3 unit. Brand new, less tubes $85.00

Airborne RF head, model AIA, delivers 50 Kw peak output at 9000 mc. at .001 duty. Complete with pulser unit and all tubes $185.00

MICROWAVE ANTENNAS

AT49/APR—Broadband Conical. 300-3300 MC. Type N Feed $8.95

Relay System Parabolic reflectors approx. range 2000 to 6000 Mc. Dimensions 4½" x 3'. New $100.00

Cone Antenna. AS 125 APR. 1000-3200 mc. Stub supported with type "N" connector $14.50

AS14A/AP. 10 CM pick up dipole assy, complete w/length of coax and "N" connectors $4.50

AS46A/APG-4 Yagi Antenna, 5 element array ... $22.50

30" Parabolic Reflector Spun Aluminum dish $4.85

APS-34 Pillbox Antenna, waveguide input; 24,000-27,000 MC $22.50

SCR 584, Dishes Perforated, Metal Construction $185.00

TPS-3. 10 Ft. Dish, "Chicken Wire" Parabola. Extremely lightweight, portable $125.00

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POWER TRANSFORMERS

COMBINATON—115V/60~ INPUT

CT 133	150-0-150V/65MA, 6.3V/2.5A, 6.3V/0.6A	$1.79
CT 005	350-0-350V/125MA, 5VCT/3A, 5VCT/2A, 2.5V/10A, 6.3V4A	8.10
CT-048	350-0-350V/90MA, 5V/3A, 2.5VCT/10A, 6.3V/3.5A	5.65
CT-003	350-0-350V/70MA, 5VCT/3A, 2.5VCT/9A	5.10
CT-007	400-0-400V/110MA, 5VCT/3A, 2.5VCT/15A, 2.5VCT/3.5A	5.35
CT-312	290-0-290V/90MA, 5VCT/3A, 6.3VCT/2.8A	3.25
CT-127	900V/25MA PK, 5V/2A, 2V/7.5A	2.79
CT-006	350-0-350V/120MA, 5VCT/3A, 2.5VCT/12.5A, 2.5VCT/3.5A	6.10
CT-965	78V/0.6A, 6.3V/2A	1.95
CT-004	350-0-350V/90MA, 5VCT/3A, 2.5VCT/12.5A	4.60
CT-002	350-0-350V/50MA, 5VCT/2A, 2.5VCT/7.5A	3.65
CT-479	7000V/.018A (2 X Ind. V. Test) 2.5V 5A/17.800 V. Test	$29.50
CT-138	520-0-520V/500MA, 6.3V/3A, 6.3V/17A, 2 X 5V/3A	14.75
CT-013	450-0-450V @ 200MA, 10V/1.5A, 2.5V 3.5A 5V/3A	6.95
CT-341	1050V/10MA—625V @ 5MA, 26V @ 4.5A 2x2.5V/3A, 6.3V @ 3A	7.50
CT-403	350VCT .026 A 5V/3A	2.75
CT-931	585VCT .086 A 5V/3A, 6.3V/6A	4.25
CT-442	525VCT 75 MA 5V/2A, 1CT/2A, 50V/200 MA	3.85

FILAMENT—115/60~ INPUT

FT-357	9VCT/35.0 Amp. Tapped PRI.	$13.50
FT-015	7.5VCT/4.0A, 2500V Test	2.55
FT-140	5VCT @ 10A 25KV Test	22.50
FT-157	4V/16A, 2.5V/2.75A	2.95
FT-101	6V/.25A	.79
FT-924	5.25A/21A, 2x7.75V/6.5A	9.95
FT-824	2x26V/2.5A, 16V 1A, 7.2V/7A, 6.4V/10A 6.4V/2A	8.95
FT-55-2	7.2V/21.5A, 6.5V/6.85A, 5V/6A, 5V/3A	8.95
FT-38A	6.3V/2.5A, 2x2.5V/7A	2.79
FT-650	2.5V/10A-3KV TEST LO-CAP	7.50

PLATE—115V/60~ INPUT

PT 034	125V/45MA	$1.15
PT 157	660-0-660 VAC (500VDC) or 550-0-550 VAC (400VDC) at 250 MADC	8.70
PT 158	1080-0-1080V (1000VDC) at 125MA Plus 500-0-500VAC (400VDC) at 150MADC Simult. Ratings	10.80
PT 159	900-0-900 VAC (750VDC) or 800-0-800 VAC (600VDC) at 225MADC	10.35
PT 167	1400-0-1400 VAC (300MADC) or 1175-0-1175 VAC (1000VDC) at 300MADC	25.50
PT 168	2100-0-2100 VAC (1750VDC) or 1800-0-1800 VAC (1500VDC) at 300 MADC	33.00
PT 371	210-0-210V at 2.12Amp	9.45
PT 133	3140/1570V, 2.36KVA	105.00
PT 801	22,000V/234 MA., 5.35 KVA, "Lo-Cap" Donut	135.00
PT 521	7500V/.06A, Half-Wave	85.00
PT 579	3100-0-3100V/2KVA, 15KV.INS. C. T. Grounded (case)	135.00

THIS MONTH'S SPECIALS

SERVO-AMPLIFIER: 2CV, 3A1, Less Tubes	$22.50
MK-12 Pressurizing Unit, for APS-2, etc.	27.50
TRANSTAT: Type TH45BG. Input: 230/130V 2Ph., 60Cy. Out: 0-260V, 11.7KVA 45Amp	165.00
INTERLOCK, Cory Type B986. Safety Type with Lock and Key. Contacts Rated at 20 Amp. DPST	2.85
TRANSTAT: Input: 130/V230V. AC 60Cy. Out: 0-260V/6.5A/1.69KVA Amertran TH 6½B used, excellent	15.00
POWER SUPPLY: PP 104/APT-5, for T-85/APT-5 Jammer	19.50
SPEAKER-TWEETER Used on Beachmaster Amplifier. Has 1½ Voice Coil and Diaphragm. Response to 20,000 Cycles. Will Handle up to 50 Watts. Complete with Spare Cone	9.95
ANTENNA-AS-33APT-2, for Jammer Transmitter	8.50
CRYSTALS. Type IN45, Western Electric	.75
VIBROPACK, PE-184: Input 12VDC/0.58 Amp. Out: 2X4.3V/50MA, 2X45VDC/0.5MA. 2X85VDC/5MA. New, Complete with Spare Vibrator. Well-Shielded and Portable	4.75

DYNAMOTORS

	INPUT		OUTPUT		
TYPE	VOLTS	AMPS	VOLTS	AMPS	Price
35X.059	19	3.8	405	.095	$4.35
POSX-15	14	2.8	220	.08	8.95
DA-7A	28	27	1100	.400	15.00
DM33A	28	7	540	.250	3.95
BD AR 93	28	3.25	375	.150	7.50
23350	27	1.75	285	.075	3.95
B-19 Pack	12	9.4	275	.110	6.95
DA-3A*	28	10	500	.050	6.95
			300	.260	
			150	.010	
			14.5	5.	
PE 73 CM	28	19	.1000	.350	22.50
BD 69‡	14	2.8	220	.08	8.95
DAG-33A	18	3.2	450	.06	4.49
DM 25†	12	2.3	250	.05	6.95

‡ Less Filter * Replacement for PE 94.
† Used, Excellent.

PE 94-C, Brand New 6.95

INVERTERS

800-1B Input 24 vdc, 62 A. Output: 115 V, 800 cy, 7A, 1 phase. Used, excellent	$18.75
PE-218H: Input: 25/28 vdc, 92 amp. Output: 115V, 350/500 cy 1500 Volt-ampere. NEW	$37.50
PE-206: Input: 28 vdc, 36 amps. Output: 80 v 800 cy, 500 volt-amps. Dim: 13 x 5⅓ x 10⅓ New	$22.50

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Full Line of JAN Approved Coaxial Connectors in Stock
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83-1AC	$0.42	83-776	.65	UG-27A/U	2.05	UG-90/U	1.15	MX-195/U	.75	UG-306/U	2.45
83-1AP	.30	UG-7/AP	6.30	UG-28A/U	2.95	UG-98/U	1.85	UG-197/U	2.80	UG-349/U	2.65
83-1F	1.10	UG-12/AP	.95	UG-29/U	.95	UG-102/U	.80	UG-201/U	1.55	MX-367/U	.85
83-1H	.12	UG-15/U	1.25	UG-29A/U	1.85	UG-103/U	.68	UG-203/U	.65	UG-414/U	1.95
83-1HP	.22	UG-18/U	1.25	UG-29B/U	1.65	UG-104/U	1.40	UG-206/U	1.40	UG-498/U	1.80
83-1J	.73	UG-18B/U	1.05	UG-30/U	2.30	UG-106/U	.12	UG-224/U	1.15	UG-536/U	1.65
83-1R	.40	UG-19/U	1.60	UG-34/U	9.75	UG-107B/U	2.45	UG-236/U	3.85	UG-625/U	.85
83-1RTY	.65	UG-20B/U	1.60	UG-36/U	12.50	UG-108/U	2.60	UG-245/U	2.25	M-358	1.30
83-1SP	.45	UG-21/U	.75	UG-37/U	17.50	UG-109/U	2.60	UG-246/U	2.35	M-359	.30
83-1SPN	.50	UG-21A/U	1.50	UG-57B/U	1.85	CW-123A/U	.45	UG-254/U	2.75	M-359A	.65
83-1T	1.30	UG-21B/U	.85	UG-58/U	.70	UG-146/U	1.95	UG-255/U	1.95	M-360	.12
83-2AP	1.95	UG-21C/U	.97	UG-58A/U	.90	CW-159/U	.60	UG-260/U	.70	PL-259	.45
83-22AP	1.40	UG-22/U	1.30	UG-59A/U	1.90	UG-166/U	32.50	UG-261/U	.80	PL-259A	.50
83-22F	2.10	UG-22B/U	1.20	UG-60A/U	1.65	UG-167/U	3.30	UG-262/U	.90	PL-274	1.10
83-22J	1.40	UG-22C/U	1.20	UG-61A/U	2.10	UG-171/U	2.25	UG-273/U	1.10	PL-284	.80
83-22R	.60	UG-23/U	1.20	UG-83/U	1.75	UG-173/U	.35	UG-274/U	2.15	PL-293	1.40
83-22SP	.80	UG-23B/U	1.50	UG-85/U	1.60	UG-175/U	.12	UG-275/U	5.50	PL-325	1.95
83-22T	1.95	UG-23C/U	1.10	UG-86/U	2.25	UG-176/U	.12	UG-276/U	5.50	SO-239	.40
83-168	.12	UG-24/U	1.30	UG-87/U	1.40	UG-177/U	.24	UG-290/U	.70	SO-264	.68
83-185	.12	UG-25/U	1.35	UG-88/U	.75	UG-185/U	.95	UG-291/U	.95		
83-765	.24	UG-27/U	1.25	UG-89/U	1.10	UG-191/AP	.80				

COAXIAL CABLES—Approved JAN Types

RG-5/U	$120.00	RG-10/U	240.00	RG-17/U	650.00	RG-22/U	150.00	RG-34/U	300.00	RG-5/8U	60.00
RG-6/U	180.00	RG-11/U	100.00	RG-18/U	900.00	RG-22A/U	285.00	RG-35/U	900.00	RG-58A/U	70.00
RG-7/U	85.00	RG-11A/U	150.00	RG-19/U	1250.00	RG-24/U	675.00	RG-54A/U	97.00	RG-59/U	60.00
RG-8/U	100.00	RG-12/U	240.00	RG-20/U	1450.00	RG-26/U	400.00	RG-55/U	100.00	RG-62/U	70.00
RG-9/U	250.00	RG-13/U	216.00	RG-21/U	240.00	RG-29/U	50.00	RG-57/U	325.00	RG-77/U	80.00
RG-9A/U	330.00										

Prices are Per M Ft.

Add 25% to prices shown for quantities under 500 feet.

SPECIAL! SPECIAL!

RG-8/U BRAND NEW GOVT. SURPLUS UNMARKED. — 100 F. COIL — $5.95

QUOTATIONS on Request on Any CONNECTORS OR CABLES NOT LISTED

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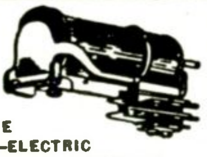
TELEPHONE RELAYS



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COOKE, AUTOMATIC—ELECTRIC
ALL TYPES of COILS and PILE-UPS

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CLARE TYPE G HALF SIZE SENSITIVE TELEPHONE RELAYS

	Coil	Contacts	Operates at	Price
1)	6500 ohms	2A	5 MA	$2.50 ea.
2)	5800 ohms	3A	4 MA	2.50 ea.
3)	5800 ohms	2B-1C	5 MA	2.50 ea.
4)	4850 ohms	1C	4 MA	2.50 ea.
4)	3600 ohms	1C	6 MA	2.00 ea.
5)	4850 ohms	1A	5 MA	2.00 ea.
6)	3300 ohms	(None)	ACTUATOR	1.50 ea.
7)	3300 ohms	1A	Micro-Switch	2.50 ea.

All above Relays may be used for continuous duty operation on 110V. D.C.

OTHER TYPE G TELEPHONE RELAYS

1)	1300 ohms	1A-1C	24 or 48V	$2.50 ea.
2)	400 ohms	1A	24V	1.65 ea.
3)	500 ohms	1D	24V	1.65 ea.
4)	200 ohms	1A	24V	1.50 ea

CLARE TYPE C STANDARD SIZE D.C. TELEPHONE RELAYS

	Coil	Contacts	Operates at	Price.
1)	1300 ohm	1B	24 to 85V.	$2.25 ea.
2)	1300 ohm	2A-1B	24 to 85V.	2.75 ea.
3)	1300 ohm	2C-1A	24 to 85V.	3.00 ea.
4)	1300 ohm	4C-2A	30 to 85V.	4.00 ea.
5)	1300 ohm	2A-1B-1C-1D	30 to 85V.	3.00 ea.
6)	1300 ohm	6C	30 to 85V.	4.50 ea.
7)	2000 ohm	2C-1A	24 to 110V.	3.00 ea.
8)	2000 ohm	4C-2A	30 to 110V.	4.00 ea.
9)	2000 ohm	6C	30 to 110V.	4.50 ea.
10)	2000 ohm	8A	36 to 110V.	3.50 ea.
11)	3000 ohm	3A	24 to 150V.	2.75 ea.
12)	3600 ohm	2C-1A	24 to 150V.	3.00 ea.
13)	110V. AC	2C-1A	110V. AC 60cy	3.50 ea.

CONTACT SYMBOLS

A=Norm. Open B=Norm. Closed C=S.P.D.T.
D=Make Before Break

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BC-733D CAATC	35.00
BC-348	145.00

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BC-221 Freq Meter	$ 89.50
LM Freq Meter	85.00

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DuMONT 3GP1 Cathode Ray Tube. Brand New. Boxed with schematic and parts list. ....$ 1.79

701A Kilowatt Screen-Grid Transmitting Tube Just right for that new final AM or SSB. New. 4.95

FILAMENT TRANSFORMER for 701A, 8V at 7½ amps 3.95

Hundreds of other tube values . . . check us!

TV TUNERS. Standard coil. Cascode with 6BQ7, 6J6. New ....$ 13.95

CERAMIC CONDENSERS. Kit of 100 asst. Brand new, standard brand. $10 value! POSTPAID 1.00

NEW POWER TRANSFORMER. 110V., 60cy. primary. 150 V. 30MA secondary 6.3-1 amps. Fil. FB for grid dip kits, test equip. etc. 79¢ ea. or 4 for $3

KLIXON THERMAL RELAY Type ER-1. Rated 30 amps at 110 V. AC. SPECIALLY PRICED AT 3 for $2 POSTPAID!

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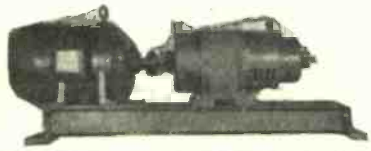
General Electric Frequency Changer. Motor: 30 HP. Triclad, 550/3/60, 3600 RPM. Direct connected to Frequency Converter, Model 5MM445BJ1, with secondary of 30 KW, 440 volts, 3 phase, 240 cycles. Price..............................$1550.00

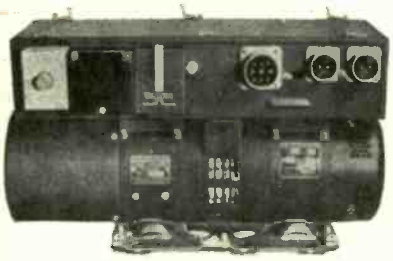
General Electric Frequency Changer. Motor: 20 HP, Triclad, 220-3-60, 3600 RPM. Direct connected to Frequency Converter, Model 5MM1365-AA1, with secondary of 10 KW, 220 volts, 3 phase, 420 cycles $1095.00

General Electric High Frequency MG. Motor: 20 HP, Triclad, 220/440-3-60, 3495 RPM. Direct connected to Alternator, Model 5A327A1, 10 KVA, 80 volts, single phase, 900 cycles, with direct-connected exciter. Complete with factory-built instrument panel having volt, amp. and frequency meters. $845.00

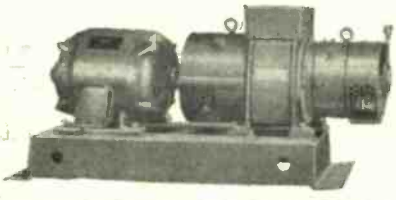


Leland MG Set. Consists of 5 HP Motor operative at 220-3-60 direct connected to self exec. alternator with output of 3 KVA, 120/208 V., 3 ph. 400 cyc. PRICE..................................$750.00

Leland MG Set. Consists of 4 HP Motor operative at 220-3-60 Direct Connected to Self Exc. Alternator with output of 2KVA, 115 V., 1 Phase 400 Cyc. Price $488.00



Wincharger PU-7/AP: Input 28 VDC. 160 Amps. Output: 115 VAC. Single ph. 2500 V.A. 400 C.P.S. Frequency and voltage regulation..........$97.00



Bogue Laboratory 400 Cycle Supply. Motor 7.5 HP, 220/440-3-60 direct-coupled to self-excited alternator output. 5 KVA. 120/208 V. 3ϕ, 400 Cy. Voltage regulated. Harmonic content less than 1%. NEW $1475.00

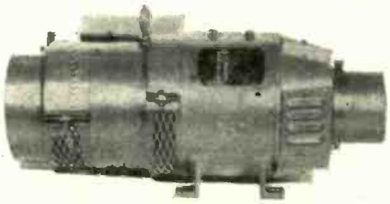
Onan 400 Cycle MG Set. Motor: 5 HP, 220/3/60. Generator: 2 KW, 115 volts, single phase, 400 CPS, self excited with secondary output of 26 volts DC, 200 watts. V-belt drive. Price...........$635.00

Louis-Allis 3 Unit MG Set. Consists of 5 HP motor operative at 220/440-3-60 directly coupled to alternator with output of 115 volts, 1 ph., 400 cyc. and with exciter unit all mounted on steel base. Price $565.00

Phone HA6-2480

Esco Frequency Changer. Type BFRS54, Pri 220/3/60, 3600 rpm, Sec 5 KVA, 3 KW, 250 Volts, 1 ph, 180 cycles..................................$225.00

Great Lakes 400 Cycle Units—These are compact, 2-bearing machines completely rebuilt and guaranteed, with output of 2 KVA, 120 volts, single phase, 420~. With motor operative at 220/440 volts, 3ϕ. 60~. Price: $320.00

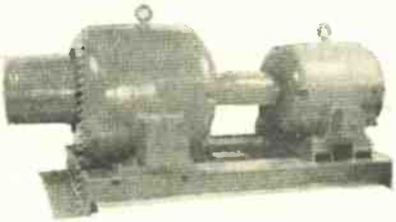


Continental 800 Cycle MG. Type CC21636, Motor: 1.5 HP, 120 VDC, 3440 RPM, directly connected Alternator with output of 120/1/800, 6.6 Amps, also 14 VDC, 4 amps..........................$114.50

Type CC21637 Same unit but with 230 VDC motor. $119.75

Type CC21607 Same unit with 220/440/3/60 motor. $155.00

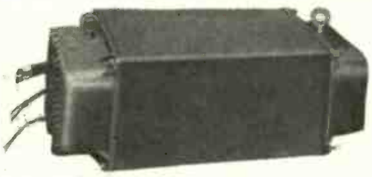
Bogue High Frequency MG. Type CGU211285. Motor: 120/80 VDC, 4000 RPM, 4 HP. Alternator: 115/1/400, 1.6 KVA, .9 P.F. DC Generator: 29.5 volts, 16 amps. Frequency regulated. Complete with magnetic starter and rheostat........$325.00



Kato Motor Generator Set. Motor: 75 HP, 220/440 V, 3 Ph., 60 Cyc., 1750 RPM. Direct connected to Alternator: 120/208 V, 3 Ph., 400 Cyc., 50 KVA, 40 KW. Model 57EPOS. Total harmonic content 2%. Voltage regulation 1%..............$4,750.00

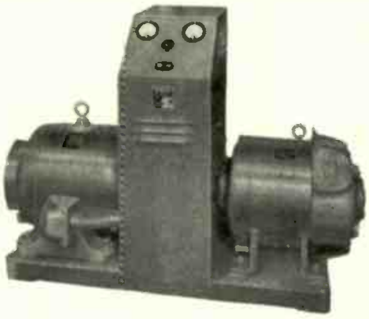
Kato 40-Pole MG Set. Motor: Synchronous, 50 HP, 220/440 V, 3 Ph., 60 Cyc., 1200 RPM. Directly connected to Alternator: 115 V, 1 Ph., 400 Cyc., no load to full load. Total harmonic content 1.5%. Voltage regulation less than 1% by magnetic amplifier $5,950.00

Kato 7.5 KVA MG Set—Motor: 12.5 HP, 220/440 volts, 3ϕ, 60~. Output: 7.5 KVA, 230 volts, single phase, 350~, with direct connected exciter. BRAND NEW. Price:......................$1,395.00

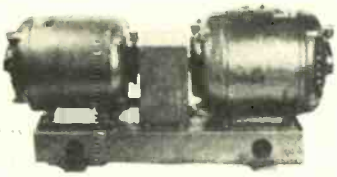


G. E. Saturable Reactors

CAT.	KVA	VAC	CIRCUIT VDC	PRICE
68G987	2.5	460	80	$ 25.00
69G217	6.0	460	125	42.00

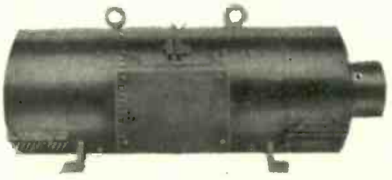


Bardco Motor Generator Set. Model MG-5-AD Motor: 7.5 HP, operative at 220 volts, 3 phase, 60 cycles, 1750 RPM, Frame 284. Direct coupled to Generator: 5 KW, 125 volts DC, 40 amperes, compound wound, drip proof panel includes: Reduced voltage motor-starter, pushbutton, field rheostat, voltmeter, ammeter, also spare parts. New..$590.00

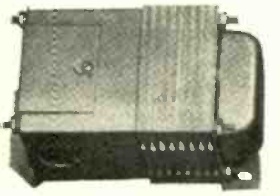


Century Low Voltage Set. Motor: .75 HP, 115/230 V, single phase, 60 Cyc., 1750 RPM. Generator: 27 VDC, 9.3 amps., comp. wound, complete with rheostat. $120.00. With 115 VDC motor...$85.00

Electric Specialty L.V. MG Set—This unit consists of a motor rated at 1.5 HP, operative at 220/440 volts, 3 phase, 60 cycles, with output of 13/26 volts DC, 39/19 amps., 1750 RPM, shunt wound, continuous duty. Price:..........................$116.50



Continental MG Set. Type CC-21523, Mtr: 230 VDC, 5 HP, 1800 RPM. Gen: 115/1/60, 2.5 KW, .8 P.F., with voltage and frequency regulation, radio filtered $114.50



General Electric Transformers. 60 cycles Cat. #64G678 Autotransformer, .5 KVA, 230/115 volts $14.75

Cat. #61G20, .5 KVA, pri. 460, Sec 115....$12.75

Cat. #61G21, .75 KVA, pri. 460, Sec 115....$22.00

Cat. #78G214. 1.0 KVA, pri 437/460/483 volts, Sec 115/330 volts..........................$22.50

Cat. #75G970, 1.6 KVA, pri 437/460/483 volts, Sec 115/330 volts..........................$25.50

Cat. #75G885, 2.5 KVA, pri 440, Sec 110...$31.50

G.E. Multi-Tap Transformer—Cat. 7406272, 4 KVA. Pri: 230 volts. Sec: 115 volts. 7 taps in 5 volt steps. Auto type. Price:......................$55.00

Raytheon Transformers — Type CRP-30382. .75 KVA. Pri: 220/440 volts. Sec: 115 volts. 4000 V. RMS. Brand new. Price:......................$23.50

Jefferson Transformers—Cat. 235-411-003. 1500 VA. Pri: 400/400 volts. Sec: 110/220 volts. Price: $27.45

G.E. Current Transformer—Type JY-285, 150:5 amps., 30:1 ratio, 25/125 cycles, 5000 volt insulation. Price:..$13.50

WILLIAM I HORLICK COMPANY

IF IT'S FROM ONE FREQUENCY TO ANOTHER; FROM DC TO AC OR AC TO DC,
IF IT'S FROM ONE VOLTAGE TO ANOTHER, THEN CALL ON US.

Est. in 1922

266 SUMMER ST.
BOSTON 10 MASS.

CRYSTALS

Guaranteed to oscillate!
Your choice of frequencies!
Largest selection in the world!

NOTE! EVERY CRYSTAL TESTED FOR ACTIVITY BEFORE SHIPMENT! All numbers listed are FUNDAMENTAL FREQUENCIES with fractions omitted.

FT-243

Lots of 10 or more. Each .69c
Lots of 5 or more. Each .79c
Individually. Each .99c

1015 1110 1129 1150 1195 1525 1900 1915 1930 1940 1950 1965 1977 1980 1985 2010 2015 2017 2020 2025 2035 2040 2060 2065 2090 2105 2125 2130 2135 2140
2145 2155 2165 2175 2180 2195 2300 2305 2320 2350 2355 2360 2365 2370 2375 2390 2415 2430 2435 2440 2442 2450 2455 2460 2465 2470 2475 2480 2485 2490
2495 2505 2510 2515 2520 2525 2530 2535 2545 2550 2557 2560 2565 2570 2575 2580 2585 2590 2595 2600 2603 2605 2610 2615 2620 2625 2630 2635 2640 2645
2650 2655 2660 2665 2675 2680 2685 2690 2695 2700 2705 2710 2715 2720 2725 2730 2735 2740 2745 2750 2755 2760 2765 2770 2775 2780 2785 2790 2795 2815
2825 2830 2835 2840 2845 2850 2855 2860 2865 2870 2875 2880 2885 2890 2895 2900 2905 2910 2915 2920 2925 2930 2935 2940 2945 2950 2955 2960 2965 2970
2975 2980 2985 2990 2995 3005 3010 3015 3020 3025 3030 3035 3040 3045 3050 3055 3060 3065 3070 3075 3080 3085 3090 3095 3100 3105 3110 3115 3120 3125
3130 3135 3140 3145 3150 3155 3160 3165 3170 3175 3180 3185 3190 3195 3200 3202 3205 3210 3220 3225 3230 3235 3240 3290 3300 3310 3320 3340 3410 3420
3455 3465 3500 3510 3525 3550 3580 3585 3640 3655 3680 3700 3760 3800 3825 3885 3940 3955 3980 3990 3995 6000 6006 6025 6040 6042 6050 6073 6075 6100
6106 6125 6140 6142 6150 6173 6175 6185 6200 6206 6225 6235 6240 6250 6273 6275 6300 6306 6315 6325 6335 6340 6350 6362 6373 6375 6405 6406 6425 6440
6450 6473 6475 6500 6506 6525 6540 6550 6573 6575 6600 6606 6625 6640 6650 7000 7006 7025 7040 7050 7073 7075 7100 7106 7125 7140 7150 7160 7173 7175
7200 7206 7225 7240 7273 7275 7300 7306 7325 7340 7350 7375 7400 7406 7425 7440 7500 7510 7520 7530 7540 7550 7560 7570 7580 7590 7600 7610 7620 7630
7640 7650 7660 7666.7 7670 7680 7690 7700 7710 7720 7730 7740 7750 7760 7770 7780 7783.3 7790 7800 7810 7820 7830 7840 7850 7860 7870 7800 7890 7891.7 7900
7910 7920 7930 7940 7950 7960 7970 7980 7990 8000 8006 8008 8010 8016 8020 8025 8030 8033 8040 8041 8050 8058 8060 8066 8070 8073 8075 8080 8083 8090
8091 8100 8106.6 8108 8110 8116 8125 8130 8133 8140 8141 8150 8158.3 8160 8163.4 8166 8170 8173 8180 8183 8190 8191 8200 8206 8208 8210 8216 8220 8225

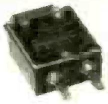
FT-243

Lots of 10 or more. Each .34c
Lots of 5 or more. Each .39c
Individually. Each .49c

4035 4045 4080 4095 4110 4135 4165 4175 4190 4215 4220 4255 4280 4295
4300 4330 4340 4395 4397.5 4445 4450 4490 4495 4535 4540 4580 4610 4620
4635 4680 4695 4710 4735 4780 4785 4815 4820 4840 4845 4852.5 4880 4900
4930 4950 4980 4995 5030 5035 5090 5127.5 5165 5180 5205 5235 5245 5285
5295 5300 5305 5327.5 5335 5385 5397.5 5435 5437.5 5485 5500 5545 5582.5 5587.5
5645 5660 5675 5687.5 5700 5706.7 5725 5730 5740 5750 5760 5773.3 5775 5780
5782.5 5800 5806.7 5820 5825 5840 5850 5852.5 5860 5873.5 5875 5880 5892.5 5900
5906.7 5907.5 5925 5940 5950 5955 5973.3 5975 5995 6206.6 6225 6240 6250 6273.5
6275 6300 6306 6325 6340 6350 6373.3 6375 6400 6406.6 6425 6673.3 6675 6700
6706.6 6725 6740 6750 6773.3 6775 6800 6806.6 6825 6840 6850 6873.3 6875 6900
6906.6 6925 6940 6950 6973.3 6975 7450 7473.3 7475 7506.6 7525 7573.3 7575 7606.6
7625 7673.3 7675 7706.6 7725 7773.3 7775 7806.6 7825 7873.3 7875 7906.6 7925 7973.3
7975 8240 8250 8273 8275 8300 8306 8325 8340 8350 8375 8400 8425 8450
8475 8500 8525 8550 8575 8600 8625 8650 8675 8690

DC-34 & DC-35 CRYSTALS
Your Choice. Ea. only 99¢

1690 1705 1720 1738 1746 1770 1790 1810 1830 1850 1870
1890 1910 1930 1950 1970 1990 2010 2030 2050 2075 2082
2090 2105 2106 2131 2155 2175 2195 2202 2215
2220 2235 2240 2255 2258 2275 2280 2295 2300 2315 2326 2335 2340 2355 2360 2375
2390 2395 2415 2422 2435 2446 2466 2467 2478 2491 2500 2510 2515 2527 2540 2559
2586 2587 2605 2625 2643 2665 2685 2710 2711 2725 2732 2745 2764 2775
2776 2807 2816 2831 2851 2853 2894 2995 2899 2925 2926 2960 2971 2980 3000 3010
3023 3027.5 3055 3077.5 3095 3117 3149 3155 3161 3190 3201 3270 3279 3280 3297 3311
3317 3365 3385 3390 3395 3412.5 3422.5 3462 3480 3485 3500 3520 3540 3550 3575 3580
3610 3630 3650 3655 3665 3680 3695 3700 3750 3760 3765
3770 3775 3790 3792.5 3807.5 3825 3830 3850 3855 3870 3885 3890 3895 3905 3920 3925
3935 3940 3950 3960 3965 3985 3995 4012.5 4015 4020 4030 4035 4050 4055 4065 4080
4085 4090 4095 4097.5 4115 4130 4135 4150 4155 4175 4177.5 4192.5 4210 4215 4235 4240
4255 4275 4280 4305 4310 4325 4335 4345 4350 4370 4380 4397.5 4415 4435 4440



FT-171

Lots of 10 or more. Each .79c
Lots of 5 or more. Each .89c
Individually. Each .99c

1151.8 1562.5 1738 1746
1940 2010 2030 2040
2045 2065 2082 2105
2123 2125 2131 2145 2150 2155 2191 2220 2258 2260
2280 2282.5 2290 2300 2305 2320 2340 2360 2390 2405
2415 2435 2442.5 2467 2470 2500 2532.5 2545 2550 2557
2582 2630 2665 2725 2780 2835 2911 2940 2967 2990
3010 3010.5 3175 3202.5 3205.5 3215 3237.5 3250 3322.5 3400
3422.5 3500 3510 3520 3550 3562 3569 3570 3580 3637.5
3660 3667.5 3682.5 3695 3700 3712.5 3760 3790 3807.5 3810
3812.5 3825 3870 3880 3945 3950 3955 3966.5 3970 3975
3980 3995 4012.5 4037.5 4050 4080 4097.5 4110 4112 4177.5
4245 4255 4280 4310 4345 4350 4360 4400 4735 5200
5225 5492.5 6000 6210 7165 7950 8000 9200 9590

DISCOUNTS FOR QUANTITY PURCHASES

WE INVITE INQUIRIES FROM FOREIGN BUYERS, AIRLINES, MILITARY AND EXPORT PURCHASERS, MANUFACTURERS, JOBBERS, WHOLESALE AND VOLUME DEALERS.

NOTE! All items subject to prior sale and change of price without notice. MINIMUM ORDER: $2.50. All orders MUST be accompanied by check, cash or M.O WITH PAYMENT IN FULL. No C.O.D. CALIFORNIA BUYERS add sales tax. INCLUDE APPROXIMATELY 5c PER CRYSTAL FOR POSTAGE. DEALERS & JOBBERS: WRITE FOR SPECIAL QUANTITY DISCOUNTS. All buyers invited to write for FREE crystal catalogue giving complete list of frequencies.

COMPLETE SETS

Individually tested and *Guaranteed* to operate!

SCR-508	Channels 0–79. FT-241 HOLDERS. Fundamental crystal frequency range: 370.370 to 516.667 KC. Set of 80 crystals	$35.00
SCR-509 & SCR-510	Channels 0–79. FT-243 HOLDERS. Fundamental crystal frequency range: 5706.7 to 8340 KC. Set of 80 crystals	$32.00
SCR-608	Channels 270-389. FT-241 HOLDERS. Fundamental crystal frequency range: 375.000 to 540.277 KC. Set of 120 crystals	$48.00
TRC-1	Channels 70–999. In 2 types of holders: TRANSMITTER Crystals in FT-241 HOLDER. Fundamental crystal frequency range: 729.167 to 1040.625 KC. RECEIVER Crystals in FT-243 HOLDER. Fundamental crystal frequency range 7500 to 8750 KC MATCHED PAIR (1 transmitter crystal and 1 receiver crystal) SET OF 300 TRANSMITTER CRYSTALS	 $1.50 $300.00
SCR-609 & SCR-610	Channels 270–389. FT-243 HOLDERS. Fundamental crystal frequency range: 5675–8650 KC. Set of 120 crystals	$48.00

FUNDAMENTAL OUTPUT FREQUENCIES

4035 4080 4165 4240
4280 4330 4397.5 4445
4495 4540 4580 4635
4710 4780 4840 4880
4930 4980 5030 5127.5
5205 5245 5285 5327.5
5397.5 5437.5 5500 5545
5587.5 5645 5687.5 5730
5780 5820 5860 5907.5
5950 5995

SCR-536 Matched pairs of Transmitter-Receiver crystals in FT-243 HOLDERS. Receiver crystal is 455 KC. higher than the frequency of Transmitter crystal.

YOUR CHOICE OF ANY MATCHED PAIR. PER PAIR $1.00

NOTE: For individual crystals, see frequencies and prices in the chart on the left.

MISCELLANEOUS & SHIP BAND FREQUENCIES

81.95	KC. Octal tube type (Used in SCR-584 & SPM-1)	$3.99
200	KC FT-241	1.99
200	KC Type DC-15 in octal tube base type holder	1.99
327.8	KC No. 241 D-168342 (need in TS-102/AP)	9.95
500	KC. FT-241	1.99
1000	KC. FT-241	2.49
1000	KC. Type DC-9, in octal tube base type holder	3.45
2000	KC. FT-243	1.99
2142	KC DC-34	2.99
2174	KC DC-34	2.99
2182	KC FT-243	2.99
2500	KC FT-243	1.99
2632	KC FT-243	2.99
2637	KC FT-243	2.99
263 F	KC. DC-34	2.99
2638	KC FT-243	$2.99
2670	KC. FT-243	2.99
2647	KC. FT-443	2.99
2670	KC DC-34	2.99
2738	KC type 1-C	2.99
2738	KC. FT-243	2.99
2788	KC. MC-7	2.99
3000	KC. FT-243	1.99
3038	KC. FT-243	2.99
3093	KC. FT-243	2.99
3098	KC. FT-243	2.99
3103	KC. FT-243	2.99
3188	KC. FT-243	2.99
3193	KC. FT-243	2.99
3198	KC FT-243	2.99
3203	KC FT-243	2.99
5000	KC. FT-243	1.99
10,000	KC. Type SR-5 Bliley, in CR-1 holder	1.99

CR-1A

Lots of 10 or more .69c
Lots of 5 or more .79c
Individually. Each .79c

5020 5041.6 5180 5208.3
5300 5520 5550 5583.3
5590 5677.7 5700 5722.2
5980 6181 6350 6380 6450 6510 6530 6550 6650
6670 6700 6740 6750 6890 7010 7020 7040 7080
7120 7130 7160 7180 7230 7350 7360 7400 7440
7460 7470 7550 7570 7590 7670 7730 7790 7810
7930 7960 7980 8007 8010 8013 8018 8020 8025
8032 8050 8060 8080 8090 8092 8103.7 8110 8115
8116 8126 8128 8132.3 8137 8140 8142.8 8146.1 8152
8172.2 8176 8193.2 8194.2 8200 8205 8216.2 8220 8260
8272.5 8284 8290 8397.1 8308 8317 8320 8328 8335
8340 8351 8357 8373 8374 8380 8392 8400 8404
8423 8428 8430 8438.7 8475 8502.8 8528.5 8554.2 8580 8590

AR7-W
1500 to 3400 KC
Ea. $2.99

FT-164
201 to 4300 KC.
Ea. $3.99

FT-241 or CR-4
300 freqs. from 729.167 to 1040.625 KC. in steps of every 1.041 KC.
Ea. 99c

COLLINS TYPE 1-C
1335 to 4467.5 KC.
Ea. $1.99

RCA MI-8412 A or B
2618 to 5805 KC.
Ea. $1.99

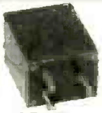
RCA MODEL AVA-10J
169 to 6510 KC.
Ea. $1.99

BLILEY TYPE MC-7 or BSD
163.94 to 8730 KC.
Ea. $1.99

AVA-53
2035 to 6910 KC.
Ea. $2.45

MX9-E
Freqs. & Prices on request.

AA9-A PIEZO ELECTRIC
1388 to 8730 KC.
Ea. $1.99



AR-4W or FT-249
1398 to 4765 KC.
Ea. $1.99

BSD 180G
956.875 to 1300 KC.
Ea. $1.9

TEST EQUIPMENT

Measurement Corp Test Set ....
TS-428 (XM-2) PCM
TS-35A/AP TS-481U
1E-19A
TS-14/AP
W.E. 17B
TS-7/ASQ
TS-102A/AP
W.E. 19C (SPC)

U. S. CRYSTALS, INC.,

Dept. E.
805 S. UNION AVE.,
LOS ANGELES 17, CALIF.

NEW ITEMS:

INVERTERS & GENERATORS:

5D21NJ3A—27 VDC input; output 110 Volt 400 cycle. I Phase 485 VA....$39.50
PE-109D—Input 13.5 VDC 29 A; output 115 V 400 cycle. 1 Phase 1.53 Amps....$59.50
PU-7/AP—Input 28 VDC 160A; output 115 V 21.6 A 400 cycle 2500 VA....$89.50
PE-118—Input 28 VDC 100 A; output 115 V 400 cycle, 1 Phase 1500 VA....Used: $14.95
PE-218—Input 28 VDC 100 A; output 115 Volt 400 cycle, 1 Phase 1500 VA....Used: $24.95 **NEW**: $49.95
PE-115 or PE-206—Input 28 VDC 36 A; output 80 Volts 800 cycle 7.2 Amps....Like New: $12.95
TYPE 800-1-D—Input 28 Volts 62 A; output 115 V 7 Amps, 1 Phase 800 cycle....Used: $39.95 **NEW**: $75.00
MOTOR AMPLIDYNE—Input 115 Volt 60 cycle 1 Phase; Output 250 Volts, 6 Amps. GE # 5AM450815 Price: $39.50
MOTOR GENERATOR POWER SUPPLY—Model BK, Set type CCL 211014—Input 115 VDC, ¾ HP Motor—Output Generator: 27 VDC 250 Watts. Price: $59.50
GASOLINE ENGINE GENERATOR — PU-6/TPS-1 Generator Output 120 Volt 400 cycle 1 Phase 1400 Watt, & 27 VDC 400 Watt. Direct drive by single cyl. air-cooled 2 cycle gas engine. Price....$175.00

COAXIAL CABLE & CONNECTORS:

CD-1071 CORD—With PL-259 Plugs each end. Removeable Vinylite Covering over Plugs. 50 ohm coax. 2 Ft. long. Price: 59¢ Each — Or Lots of 10 @ **50¢ Ea.**
PL-259—Plug ea. end & 32"—RG-54/U—58 ohm.50¢
UG-21/U—Plug ea. end & 32"—RG-11/U75 ohm.50¢
UG-22/U—with 4" Coaxial Cable....50¢
RG-8/U (SPECIAL) 51.5 ohm. Same size as RG-8/U. Prices: 1 to 100 ft. @ 8¢ per ft.—100 to 500 ft. @ 7½¢ per ft.—500 to 1000 ft. @ 7¢ per ft.—1000 ft. Rolls (or more) @ 6½¢ per ft.
RG-34/U—71 ohm, 145 ft. length....$15.00

SOUND POWERED PHONES:

HEAD AND CHEST SET—NAVY TYPE— No batteries required. Ideal for TV Antenna installations, and many other uses. 20 Ft. Cord. Used—Tested....Each: $5.95

NEW ITEM **HANDSET TS-10**
Sound Powered—Used—Tested.... **$6.95**

BLOWERS:

115 VOLT 60 CYCLE BLOWER—Approx. 100 CFM Dis. 2¼" intake - 2" outlet. Quiet running. Motor size: 2½" x 3¼". NEW—Not Gov't. surplus. Order No. 1C939....$8.95
DUAL BLOWER — Same as RN-520 above, except has blower assembly in each side of motor. Order No. IC880....$13.95
COMPACT TYPE — 108 CFM motor built Inside squirrel case, 4-½" Intake: 3-⅝" x 3" Dis. Complete size: 4-¼" W. x 9-⅝" H. x 8-½" D. Order No. 2C067....$14.50
FLANGE TYPE—140 CFM, 3-½" Intake: 2-½" Dis. Complete size: 8½" W. x 7¼" H. x 6¾" D. Order No. 1C807....$13.95
FLANGE TWIN—275 CFM, 4-½" Intake: 3-¼" x 3" Dis. Complete size: 11-¾" W. x 9-⅝" H. x 8-1/16" D. No. 2C069....$21.95
MINIATURE BLOWERS—24 VDC; oblong Outlet 1" x ⅞". Dual 20 CFM $7.95. Single 10 CFM $5.95

MOTORS:

24 VDC REVERSIBLE MOTOR—3.7 RPM, 40 lb. Torque. Motor size: 5-⅛" x 4-1/32" x 3-5/16". Shaft size: 21/32" x 5/16". Also operates 24 VAC. Philco No. 441-1008....$5.95
27.5 VDC—6000 RPM, 1.5 oz. in. Shaft size: 1-⅛" x ¼". Motor size: 2-½" x 1-½". No. 5069-267 $6.95
24 VDC AIRWAY MOTOR—Model #Z-350. Approx. 5000 RPM. Motor size: 2-⅛" x 1-⅝". Shaft size: ½" x ¼"....Price: $2.95
26 VOLT 60 CYCLE—60 RPM Synchronous Cramer Motor #1147. Shaft size: 1" x ⅛"....$1.95
110 VDC 1/70 HP. 1550 RPM. Motor size: 4" x 2½". Shaft size: 1" x 3/16". Redmond #157....$4.95
6 VDC 1/20 HP. 4000 RPM. Motor size: 5" x 3". Shaft size: ¾" x ¼". Redmond #E-56 Price: $4.95
12 VDC 1/30 HP. 4500 RPM. Motor size: 3" x 2-½". Shaft size: 1" x 3/16". Delco #5047520....$4.95
27 VDC—1-10 HP—3500 RPM. Shaft Size: ⅝" x ¼". Motor size: 4" x 3-½". Air Assoc. No. EE-763..$6.95
80 VDC—1/50 HP—3000 RPM. Shaft Size: ⅝" x ¼" Motor Size: 5" x 3". G.E. No. 5 PN38HA10..$8.95
28.5 VDC—1/35 HP — 2200 RPM, Shaft Size: 1-½" x ¼". Motor size: 4-½" x 3-¾". Electrolux No. 16876....$5.95

NEW ITEM **115 VAC 60 Cycle Induction Motor**—1.9 RPM, 75 Torque oz. in.; 9 Watts—with variable Multiple Disc Coder Wheel and Micro Switch, mounted on bracket assy. Holtzer Cabot Motor Type RWC 2505....$9.95
GEARED HEAD MOTOR—Heavy Duty, 24 VDC 8 Amp. 2-½ lb. Torque: 100/200 RPM Shaft size: 5/16" x 1". Right Angle Drive....$8.95

TRANSFORMERS:

110 VOLT 60 CYCLE PRIMARIES:
5 VOLT CT-25A—10,000 V. ins. OPEN FRAME—3" x 5" 4-½"....$7.95
Sec Two 12 V. 4A Winding — gives 12 V. 8 A. or 24 V. 4 A....$5.95
Sec. 24 V. ½ A....$1.50 Sec. 24 V. 1 A....$4.95
Sec. 24 Volt 6 Amps....$3.95
Sec. 6-24 or 30 Volts. 8 Amps....$5.95

AUTO—TRANSFORMERS:
230 Volt to 115 Volt 60 cycle 20 KVA. Stock #3115620-25 Jefffries Type EA....Price: $69.50
230 Volt to 115 Volt 60 cycle 250 Watt. Jefferson # 352-7093....Price: $5.95

RECORDER, SIGNAL GENERATOR—AMPLIFIER, & Voltage REGULATOR

RECORDER, SIGNAL GENERATOR—AMPLIFIER, AND VOLTAGE REGULATOR UNIT of BC-963 TRAINER — Used for assimilated Radar identification when used with BC-412 Scope. Signal Generator generates various AC wave forms. Recorder was used to record difference in scope and generator wave forms as guided by operator. 110 Volt 60 cycle operation—with Manual. Shipping Weight: 270 lbs. Complete Unit....NEW: **$59.50**

OR AVAILABLE AS SEPARATE ITEMS:
SIGNAL GENERATOR—AMPLIFIER: Can be adjusted for various wave forms, 110 Volt 60 cycle operation. Voltage regulated supply 300 Volt 100 MA. 6.3. 5 A.: 5 Volt 3 A. Power Supply. 15 Tubes: 1/7A6, 3/7A8, 3/7F7, 3/7N7, 1/5Y3GT, and 4/VR1150 With Tubes and Manual.... **$19.95**
RECORDER—Complete with 115 V, 60 cycle 1/125 HP Gear Head Motor, Veeder Counter, Pen, etc. and with Manual.... **$19.95**
CONSTANT VOLTAGE REGULATOR—115 V. 60 cycle, 80 VA, Sola #30726.... **$14.95**

ADDRESS DEPT. E • All Prices Are F.O.B., Lima, Ohio • $5 Minimum Order & 25% Deposit on C.O.D.'s

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LIMA, OHIO

A GREAT BUY!! A SMASH OFFER!!

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Lots of 100......$1.35 Lots of 50......$1.45

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STANDARD BRAND—NEW—*Jobber*—BOXED
CURRENT 1954 DATING • 90 DAY GUARANTEE
AVAILABLE NOW!! • BUY NOW!!

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READY CASH FOR YOUR TUBE INVENTORY

SOLO ELECTRONICS SALES CORP.
190 Washington Street New York 7, N. Y.
Phone: WOrth 2-1042

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1CT Cont. Trans. 90/55V 60~	$60.00
1D Diff. Mtr. 90/90V 60~	99.50
1DG Diff. Gen. 90/90V 60~	60.00
1F Syn. Mtr. 115/90V 60~	60.00
1G Gen. 115/90V 60~	60.00
1HCT Cont. Trans. 90/55V 60~	72.50
1HDG Diff. Gen. 90/90V 60~	72.50
1HG Gen. 115/90V 60~	72.50
1N Syn. Mtr. 115/90V 60~, Bendix	45.00
1N Syn. Mtr. 115/90V 60~, Henschel	27.50
1SF Syn. Mtr. 115/90V 400~	17.50
2J1A1 Gen. 115VAC 400~	17.50
2J1A2 Gen. 115VAC 400~	17.50
2J1B1 Cont. Trans. 55VAC 400~	17.50
2J1D1 Gen. 115/90V 400~	12.50
2J1E1 Cont. Trans. 57.5VAC 400~	17.50
2J1F1 Gen. 115/57.5V 400~	9.50
2J1F3 Gen. 115/57.5V 400~	9.50
2J1FA1 Gen. 115/57.5V 400~	17.50
2J1G1 Cont. Trans. 57.5/57.5V 400~	9.50
2J1H1 Diff. Gen. 57.5V 400~	12.50
2J1H2 Gen. 115/57.5V 400~	12.50
2J1M1 Cont. Trans. 105/63VAC 60~	60.00
2JD1P1 Syn. Mtr. 115/90VAC 60~	60.00
2J5A2 Gen. 115/105VAC 60~	34.50
2JD5A2 Syn. Mtr. 115/105V 60~	50.00
2J5A4 Gen. 115/105VAC 60~	50.00
2JD5C2 Syn. Mtr. 115/105V 60~	50.00
2J5F1 Cont. Trans. 105/55V 60~	50.00
2J5FB1 Cont. Trans. 105/55V 60~	60.00
2J5H1 Gen. 115/105V 60~	50.00
2J5HA1 Gen. 115/105V 60~	60.00
2JD5HA1 Syn. Mtr. 115/105V 60~	60.00
2JD5HB1 Syn. Mtr. 115/105V 60~	60.00
2J5J2 Gen. 115/90V 60~	60.00
2JD5J2 Syn. Mtr. 115/90V 60~	60.00
2J5K2 Cont. Trans. 90/57.5V 400~	50.00
2J5K3 Cont. Trans. 90/55V 60~	60.00
2J5L1 Cont. Trans. 105/55V 60~	60.00
2J5LA1 Gen. 115/105V 60~	60.00
2JD5R1 Syn. Mtr. 115/90V 400~	27.50
2J5RB1 Diff. Gen. 90/90VAC 400~	37.50
2J6F1 Gen. 115/105VAC 60~	60.00
2J6F2 Gen. 115/90VAC 60~	60.00
2J6F3 Gen. 125/105VAC 60~	60.00
2J8A1 Syn. Mtr. 120 Volts D. C.	80.00
2J15B2 Cont. Trans. 90/57.5V 400~	37.50
2JA39BB2 Syn. Mtr. 110/55V 60~	60.00
2J55JB1 Gen. 110/55V 60~	60.00
2J55V1 Gen. 110/55V 60~	60.00
2JD55V1 Syn. Mtr. 110/55V 60~	60.00
2J65F1 Gen. 110/55VAC 60~	60.00
2JDA66PA5B Mtr. 110/55VAC 60~	42.00
2JD123A16 Mtr. 110/55VAC 60~	38.00
5A Syn. Mtr. 115/90V 60~	22.50
5B Syn. Mtr. 115/90V 60~	22.50
5CT Cont. Trans. 90/55V 60~	45.00
5D Diff. Mtr. 90/90V 60~	50.00
5DG Diff. Gen. 90/90V 60~	50.00
5E Arma Gen. DRG213315	50.00
5F Syn. Mtr. 115/90VAC 60~	45.00
5F400 Syn. Mtr. 115/90VAC 400~	50.00
5G Syn. Gen. 115/90VAC 60~	45.00
5HCT Cont. Trans. 90/55V 60~	65.00
5HG Syn. Gen. 115/90VAC 60~	80.00
5G Special Gen. 115/90VAC 400~	29.50
5HG400 Gen. 115/90VAC 400~	60.00
5M Syn. Mtr. 115/90VAC 60~	22.50
5N Syn. Mtr. 115/90VAC 60~	22.50
5SB Cont. Mtr. 115/90VAC 60~	60.00
5SCT Cont. Trans. 90/22.5VAC 60~	50.00
5SDG Diff. Gen. 90/90V 400~	37.50
5SF Syn. Mtr. 115/90VAC 400~	32.50
5SG Gen. 115/90VAC 400~	32.50
5SG, KS5950-L2, Gen. 115/90V 400~	22.50
5SN Cont. Mtr. 115/90VAC 60~	60.00
6CT Cont. Trans. 90/55VAC 60~	55.00
6DG Diff. Gen. 90/90V 60~	60.00
6G Syn. Gen. 115/90VAC 60~	50.00
6SG Syn. Gen. 115/90VAC 60~	50.00
7DG Diff. Gen. 90/90V 60~	67.50
7G Syn. Gen. 115/90VAC 60~	60.00
18CT4 Cont. Trans. 90VAC 400~	45.00
FJE22-1 Syn. Repeater 115VAC 400~	27.50
R210-1A Kearfott Trans. 26/11.8V 400~	59.50
R220-1A Kearfott Repeater 26/11.8V 400~	59.50
R235-1A Kearfott Resolver 26/11.8V 400~	59.50
81E115 Trans. 115/90VAC 60~	45.00
5MJ35CB1A GE Syn. Mtr. 55/55V 60~	85.00
ZL26JF3117 Wag. Syn. Mtr. 115V 60 Cy. 180 RPM	45.00
8TJ9PXAN GE Transmitter 24V	9.50
Magslip Transmitter GE Patt. 6547 MKII	12.50
Magslip Transm. Patt. 6548 3"	12.50
[illegible]0-1 Transm. #14-000-109 120/90VDC	19.50
C44968-6 Repeater 115v 60~	17.50
C44969-8 Transm. 115 60~	22.50
C56701 Type II-4 Rep. 115V ~	22.50
C56776-1 Type II-5 Rep. 115V 6 ~	22.50
C69405-2 Type I-1 Transm. 115V 60~	22.50
C69406 Syn. Transm. 115V 60~	22.50
C69406-1 Type II-2 Rep. 115V 60~	22.50
C76166 Volt. Rec. 115V 60~	17.50
C76535, FJ84-2 Volt. Rec. 115V 60~	17.50
C77610 Syn. Rep. 115V 60~	17.50
C78248 Syn. Transm. 115V 60~	17.50
C78249 Syn. Diff. 115V 60~	7.50
C78254 Type XII Diff. 115V 60~	22.50
C78359, FJE84-4, Rec. 115V 60~	22.50
C78360, FJE84-5, Trans. 115VAC 60~	22.50
C78410 Syn. Rep. 115VAC 60~	22.50
C78411 Transm. 50VAC 50~	14.50
C78414 Transm. 115VAC 60~	22.50
C78415 Type V Rep. 115VAC 60~	22.50
C78791 Transm. 115VAC 60~	17.50
C79331 Transm. 115VAC 60~	17.50
C81639 Rep. 115VAC 60~	22.50
C82052 Type XIX Diff. 115V 60~	22.50

All synchros fully guaranteed to meet customers' specifications. Fob Boston. Allow us to quote you on any of your rotating equipment requirements, such as Rate Generators or Motors, Servo Motors, Autosyns, Kollsman Units, Resolvers, Etc.

ELECTRO SALES CO., INC.
50-58 Eastern Avenue, Boston 13, Mass.

We STOCK for IMMERIATE SHIPMENT one of the MOST COMPLETE inventories of SPECIAL-PURPOSE, TV, & RADIO TUBES. We offer fully guaranteed, STANDARD BRANDS at the LOWEST PRICES, consistent with HIGHEST QUALITY. SPECIAL ATTENTION to EXPORT ORDERS.

2C39A	Jan Orig. Mfg. Cartons	16.50
2E24	R.C.A. Jan	2.25

304TH **304TL**	Eimac, New Surplus Boxed	$4.90

July-August, 1954 Special!

2J32	Magnetron Boxed	15.80
2K45	W. E. Boxed	85.00
2K55	W. E. Boxed	40.00
3DP1	R.C.A. Boxed	2.25

872A	G. E. Boxed	$2.75

Other Brands—$1.70

4D32	Raytheon Boxed	20.00
6AK5	Hytron Jan Boxed	60¢

NOW ON OUR PREMISES
Certified Laboratory Testing Facilities
Specialized Electronic Tube Testing to Your Specs.

FG17	G. E.	3.00	**GL-434-A**	G.E. Boxed	9.00
HK54	Orig. Box	4.00	**KU610**	Westinghouse Boxed	15.00

Remember! We Ship No Seconds or Rehashed "Bargains." You can Place Your Confidence in Our Dependable *NEW* Tubes. We Ship the Best—First Quality RCA, GE, SYLVANIA, WESTINGHOUSE, HYTRON and RAYTHEON TUBES Insure Repeat Orders From You—Our Customers.

100TH	Eimac, Surplus Orig. Jan Box	4.50	**703A**	Orig. Jan Boxed	3.00
310A	W. E. Boxed	3.75	**705A**	W. E. Boxed	60¢

NEW COMMERCIAL PRODUCTION!

5C22 Mfd. by the pioneer of HYDROGEN THYRATRONS-PENTA LABS. **$34.90**

723A/B	W. E. Boxed	14.00
724B	Jan Boxed	98¢

407A **408A**	W. E. Boxed	$3.00

750TL	Eimac Jan Boxed	75.00
826	RCA Jan Boxed	45¢
869B	Federal	35.00
921	RCA Boxed Photo Tubes	1.65

5654	In Orig. Cartons of 100 Each	$1.50

1620	RCA Jan	3.95
1626	Jan Boxed	15¢

THIS REPRESENTS OUR SPECIALS FOR THIS MONTH. WRITE OR CALL FOR OUR *COMPLETE* TUBE LISTING.

SELENIUM RECTIFIERS
FULL-WAVE BRIDGE TYPE

Max. Amps	18/14 Volts	36/28 Volts	54/42 Volts	72/56 Volts	130/100 Volts
1	1.40	2.40	3.80	4.60	8.50
2	2.10	3.00	5.40	6.00	10.50
2½	3.60	4.20	6.00	8.00	13.00
4	3.75	7.50	11.50	14.50	22.25
6	4.50	9.00	13.00	17.50	33.00
10	6.60	12.75	20.00	25.00	42.50
12	8.20	16.25	22.50	30.00	46.00
20	13.25	25.50	38.00	49.00	79.50
24	16.25	32.50	45.00	58.00	86.50
30	20.00	38.00	57.50	72.00	.....
36	25.00	48.50	66.00	88.00	.....
50	32.00	62.50	.....	.....	.....
100	60.60	120.00	.....	.....	.....

NEW RECTIFIER CHOKES

1 Amp —.1 Hy—1.5 ohms	$3.95
2 Amps—.04 Hy—.9 ohm	4.15
4 Amps—.07 Hy—.6 ohm	7.95
12 Amps—.01 Hy—.1 ohm	14.95
24 Amps—.004 Hy—.025 ohm	29.95

NEW RECTIFIER TRANSFORMERS

PRI: 115 V., 60 cycles in.
SEC: 9, 12, 18, 24, and 36 volts
Continuous Ratings.....

1 Amp.	$5.75
2 Amps.	6.75
4 Amps.	8.75
12 Amps.	16.75
24 Amps.	35.75
30 Amps.	45.00
50 Amps.	59.75

We Build other Selenium Rectifiers, Transformers and Chokes to your specifications.
Buy from the Direct Source for Quick Delivery.

FILTER CAPACITORS

Capacity	W. Voltage	Ea.
500 MFD.	50 V.	.85
1000 MFD.	15 V.	.35
2000 MFD.	50 V.	2.25
6000 MFD.	15 V.	1.50

TUBE CARTONS

Two-Colored Cartons With New Safety Partitions. . . Super-Gloss Red and Black Carton is the Most Distinctive Box Available Today.

SIZE		EACH
Miniature	(6AU6, 6AL5, etc.)	$.01
GT	(6SN7, 6W4, etc.)	.0125
LARGE GT	(1B3) 6BQ6GT, etc.)	.015
LARGE G	(5U4G, 6BG6G, etc.)	.02

Terms: F O B N Y C—25% Deposit with order—or send full remittance to save C O D charges—Well-Rated Firms (D. & B.) Net 10 days—All merchandise guaranteed. CABLE BARRYLECT, N. Y.

AUTHORIZED DISTRIBUTORS FOR EIMAC, WESTINGHOUSE (WL), CBS-HYTRON (CBS), CETRON, LEWIS & KAUFMAN AND PENTA TUBES.

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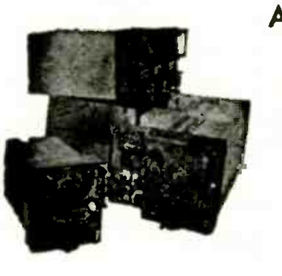

AN/APR-4 LABORATORY RECEIVERS

Complete with all five Tuning Units, covering the range 38 to 4,000 Mc.; wideband discone and other antennas, wavetraps, mobile accessories, 100 page technical manual, etc. Versatile accurate, compact — the aristocrat of lab receivers in this range. Write for data sheet and quotations.

We have a large variety of other hard-to-get equipment, including microwave, aircraft, communications, radar; and laboratory electronics of all kinds. Keleket alpha scalers and chambers, dosimeters and other nucleonics now in stock. Quality standards maintained.

NEW TS-13/AP X-BAND SIGNAL GENERATORS with manual $575.00; TS-175/U Frequency Meter 85-1,000 Mc. $485.00; H-P, Boonton, G-R, Measurements, many others in stock.

ENGINEERING ASSOCIATES
434 PATTERSON ROAD
DAYTON 9, OHIO

SPECIAL DEAL!

100TH . . . . $4.50 EA.

DISCOUNT ON QUANTITY ORDERS

FS-2404, Electronics
330 W 42nd St., New York 36, N. Y.

FOR SALE 1000 KLIXON

THERMOSWITCHES

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MAKE OFFER FOR LOT.

NATIONAL SURPLUS SALES
MIDWEST'S LARGEST SURPLUS DEALER
719-23 E. 18th K. C., Mo.

TREMENDOUS SACRIFICE
Natvar-Yellow Varnished Cambric
Seamless Bias Tapes

2500 Gross Yards—.005" x ¾"—72 yd. rolls
2500 Gross Yards—.007" x ¾"—72 yd. rolls
$1.05 per gross yard in quantities of 1,000 gross yds.
$2500. for the two lots—f.o.b. your plant

J. M. HIRSCH COMPANY
622 Washington St. San Francisco 11, Calif.

RELAY SPECIALISTS
AUTHORIZED FACTORY DISTRIBUTORS
STRUTHERS-DUNN POTTER & BRUMFIELD

GUARDIAN STEPPERS—ACRO COIN SWITCHES
MIDGET RELAY—1¼" Long
DPNO + SPDT—6/12 or 24 v. coil $15.00/doz.
6 Pole D.T. # BN 18D 39 110 v. DC coil $8.95

RADIO DEVELOPMENT & SALES CO.
323 ATLANTIC AVE. · ULSTER 5-0488 · BKLYN. 1, N.Y.

REDUCED PRICES

BROWN BALANCING MOTOR

Minneapolis Honeywell reversible two phase gearhead servo motor. 115 volts 60 cycles. Models with the following speeds available: 18-20, 20-27, 25-30, 27, 30, 35-40, 54, 50-60, 60, 110-130, 150-180, 162 and 180.

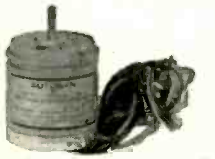
SA-436 . . . . **$19.50**

TYPE AYLZ 3055S MICROPOSITIONER

Barber-Colman. Polarized d-c relay. Double coil differential current sensitive. 50 volts max. per coil. Alnico (P.M.) Field. Use for remote control, positioning, etc.

SA-437 . . . . **$6.75**

PIONEER PRECISION AUTOSYNS



We have quantities of the following Autosyns which were removed from new equipment. All have long leads and are guaranteed. Priced at a fraction of original cost.

AY-101 D Transmitter or Receiver	$14.50
AY-131 D Differential	$14.50
AY-130 D Differential	$14.50
AY-123 Resolver	$24.50
AY-103 Transmitter or Receiver	$14.50
AY-201-3-B Transmitter or Control Transformer	$17.50
AY-221 Resolver	$27.50
AY-231-3-B Differential	$19.50
AY-201S-3-B Transmitter or Control Transformer	$17.50

DIEHL P.M. MOTOR

Type FD6-21 27.5 volts d-c single shaft with speed of 10,000 rpm WE No. KS-15098L01. Ideal for models, blowers, etc.

SA-433 . . . . **$6.75**

U. S. NAVY SYNCHROS

We have in stock large quantities of Navy Ordnance Synchros guaranteed to meet original manufacturers' specifications. The following are a few of the most popular types: 1F, 1G, 1CT, 1DG, 5F, 5G, 5CT, 5 DG, 5D, 5HCT, 5SF, 5SG, 6G, 6CT, 6DG, 7G, 7DG. Our stock also includes Army Ordnance, G-E, Bendix, Henschel & Diehl types. Write for quotations.

Servo-Tek

PRODUCTS CO.
INCORPORATED
1086 Goffle Rd. Hawthorne, N. J.
HAwthorne 7-3100

Condensers SPECIALS

10 mfd.—600 v . . . . . . **$.98**

Three term, bot. mtg. channel type. Dims. 3¾" x 2½" x 2". Two 5 mfd. sections rated 400 V at 72 deg "C". 1800 V test. Meets commercial specs. for 600 V operation up to 40 degs "C". Ideal for filter or power factor application. Repeat sales prove this rugged high quality condenser to be of outstanding value. Carton of 24, weight 42 lbs. Large qua. available **$.89**

8 mfd.—600 V **$1.49**
2" dia. x 4½" H. Bkt.

2 mfd.—600 V . . . . **$.85**
2 S.T. Bothtub

4 mfd.—1000 V **$1.75**
4 mfd.—600 V **$1.25**
1 mfd.—400 V . . . . **$.29**
Channel—Rev. Mtg. Bkt.

16 mfd.—600 V **$1.89**
Dual 8 mfd. herm. sealed and packed. Type PT. SC-11 measuring 3¾" x 2⅝" x 2⅝". Stud. mtg. centers 2". Plugs into standard for prong socket.

Mfd.	Volts	Price	Mfd.	Volts	Price
.0016	15KV	$5.75	1	25KV	70.00
.0023	16KV	5.95	2	600V	.59-.9
.005-.005-			2	1000V	.5
.01	10KV	4.75	2	1000VTLA	1.29
.012	25KV	22.50	2	1500V	1.69
.02	10KV	5.25	2	2000V	2.80
.02	20KV	17.90	2	2500V	3.95
.025-.025-			2	3000V	5.80
	50KV	34.50	2	4000V	7.95
.03	7500V	4.95	2	5000V	12.50
.03	16KV		2	6000V	15.95
.035	10KV	12.95	2	7500V	29.95
.05	5KV	2.49	2	10KV	39.95
.05	7500V	2.95	2-2	600V	1.25
.08	12.5KV	15.95	3	600V	.59
.1	1500V	.59	3	4000V	11.95
.1	2000V	.49	3-3	150V	.35
.1	2500V	1.39	3-3-3	400V	1.05
.1	3000V	1.69	4	600V	1.25
.1	5000V	1.95	4	600VTLA	1.45
.1	7500V	1.75	4	600VTLAD	1.40
.1	7500V	3.50	4	100V	1.95
.1	10KV	9.50	4	1500V	2.65
.1	10KV	12.95	4	2000V	4.35
.1	12KV	14.95	4	2500V	5.95
.1	12KV	14.95	4	3000V	7.55
.1	25KV	29.50	4	4000V	13.95
.125	27.5KV	39.50	4	5000V	24.95
.1-1	2000V	.98	4 mfd	6000V	32.95
.1-.1	7500V	3.50	4	7500V	52.50
15-.15	8000V	1.95	4-4-4	600V	2.40
.2	10KV	10.55	5	330VAC	1.75
.2	15KV	17.95	5	600V	1.75
3x.2	4000	2.85	5	1000V	1.99
.25	1000V	.48	5	1500V	2.45
.25	2000V	1.35	6	330VAC	1.75
.25	2500V	1.29	5-5	600V	1.35
.25	6000V	1.75	6	600V	1.85
.25	4000V	3.25	6	1000V	2.49
.25	3000V	1.45	6	1500V	3.65
.25	15KV	15.95	6	2000V	3.95
.25	20KV	19.95	6	4000V	27.50
.25	25KV	29.95	7	600V	1.45
.25	32.5KV	59.50	7	800V	1.99
.25	50KV	67.50	8	500V	1.35
.3	2000V	1.45	8	600V	2.25
.4	10KV	19.95	8	600V RG	1.79
.5	1000V	.55	8	660VAC	3.50
.5	1500V	1.20	8	1000V	3.25
.5	2000V	1.85	8	1500V	4.25
.5	2500V	2.20	8	2000V	7.25
.5	3000V	2.39	8-8	600V	1.89
.5	4000V	3.15	8-8-8	500V	2.25
.5	5000V	4.15	10	600V	2.75
.5-.1	2000V	.90	10	660VAC	5.90
.5-.5	600V	.69	10	1000V	4.55
.5-.5	1000V	.69	10	1500V	6.25
.5-.5	12.5KV	19.50	10	2000V	6.75
.5	25KV	55.50	10	6000V	99.50
1	400V	.45	12	1000V	4.95
1	500V	.59	12	1500V	6.25
1	1000V	.69	12	2000V	8.25
1	1500V	1.35	15	330VAC	3.95
1	2000V	1.95	15	440VAC	4.95
1	2500V	2.50	15	600V	3.25
1	3000V	3.35	15	1000V	5.35
1	5000V	6.85	15	1500V	6.35
1	6000V	7.95	15	5000V	63.50
1	7000V	12.60	16	1500V	8.95
1	7500V	14.95	20	600V	5.85
1	10KV	27.95	20	330VAC	4.69
1	15KV	47.50	28	1000V	7.50
1	16KV	49.50	30	330VAC	5.25
1	20KV	59.50	30	2500V	14.60
			80	4000V	49.50

DIESEL GEN.

25 KW 3 phase 60 cy. Hill diesel, G.E. gen. Complete with control panel & starting batteries. Ready for immediate operation. Guaranteed. P.U.R.

—ALSO—

BATHTUB & CHANNELS — TUBULAR OILS — MICAS — TRANS & REVG — "J" POTS — RHEOSTAT — 25 WATT

WANTED

Oil & Mica Condensers in any quantity.
Also other Standard Components.
Write: Art Hankins

See JUNE *Issue*

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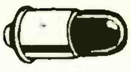
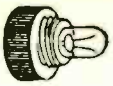
Long Branch 6-5192

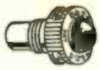
GRAIN OF CORN LAMPS



#328
28 Volts



#326
2½ Volts



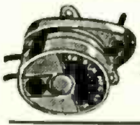
#321
28 Volts

½" Ford Spark Coil by Delco-Remy $2.75

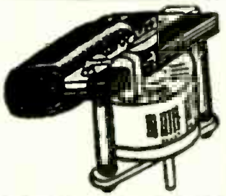
Edwards Size "0" LUNGEN BUZZER 1" x 1¼" **$1.45**

SMALL BLOWER OR AGITATOR FOR COOLING T.V. ETC. **$4.50**

HAYDON TIMING MOTORS



110v. 60 cycle 30 RPM	$2.60
110v. 60 cycle 1 RPM	2.85
230V 60C 1 RPM	1.00
230V 60C 2 RPM	1.00



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OA5	3.50
OB2	1.00
OC3/VR105	.90
OD3/VR150	.85
1B22	1.50
1B23	4.00
1B24	6.75
1B26	1.75
1B27	11.00
1B32/532A	1.75
1B35	5.50
1B42	8.25
1B63A	49.50
1D21/SN4	3.75
1N21B	2.00
1N23B	2.00
1N34A	.79
1N35	1.05
1N38	1.50
1N44	1.70
1N47	4.50
1N55	2.75
1N63/K63	1.05
1N69	.59
1P28	7.75
1P29	2.00
1P36	2.75
1P39	1.20
1Z2	2.00
VS-2	7.50
2B22	2.25
2C21x1642	.69
2C36	25.00
2C39	12.50
2C39A	13.00
2C40	7.25
2C42	10.00
2C43	13.95
2C44	.89
2C46	10.00
2C51	3.69
2C52	3.00
2D21	1.15
2D21W	2.49
2E24	3.30
2E26	3.25
2E35	1.40
2J26	5.00
2J27	7.50
2J31	17.50
2J32	17.50
2J33	20.00
2J34	17.50
2J36	89.00
2J42	105.00
2J49	59.50
2J51	195.00
2J56	89.50
2J61	24.50
2J62	11.00
2K22	17.50
2K23	19.95
2K25	20.00
2K26	50.00
2K28	25.00
2K33A	65.00
2K34	139.50
2K41	125.00
2K42	139.50
2K45	110.00
2K48	99.50
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3B23	4.05
3B24	4.25
3B26	3.50
3B28	5.95
3B29	6.95
3C22	72.50
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3C24/24G	1.10
3C27	3.75
3C33	9.95
3C45	9.50
3E29	9.50
3FP7	1.95
3GP1	1.95
3JP1	12.50
3K27	199.50
3K30	199.50
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4C35	17.50
4J26	99.50
4J28	99.50
4J29	99.50
4J30	149.50
4J31	99.50
4J34	75.00
4J36	99.50
4J42	79.50
4J52	199.50
4J57	299.50
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4X150A	27.50
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5BP2A	4.95
5BP4	2.50
5CP1A	14.50
5C22	27.50
5CP7	9.50
5D21	9.50
5FP7	1.95
5FP14	7.50
5HP1	3.95
5HP4	3.95
5JP1	17.50
5JP2	17.50
5JP4	17.50
5JP5	17.50
5J23	29.50
5J26	120.00
5J29	10.00
5J30	19.95
5J33	7.50
5MP1	3.95
5NP1	3.95
5R4GY	1.25
5R4WGY	1.60
C6L/5528	6.50
C6J	7.25
6AL5W	1.60
6BL6	60.00
6BM6	69.50
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6F4	3.00
6J4	4.50
6SU7GTY	2.75
7C22	99.50
7C24	75.00
12DP7	13.00
12GP7	17.50
12HP7	13.50
15E	1.75
KC4	39.50
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RK60/1641	1.95
FG67/5728	15.00
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RK73	.95
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83V	1.10
FG95/5560	22.50
ML-100	write
100TH	7.50
HF120	9.95
FG104	29.50
FG105	17.50
F-123A	7.79
VT-127A	2.75
VT158	17.50
QK159	149.60
FG172	22.50
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217C	4.95
251A	.98
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250R	6.95
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250TL	12.50
251A	49.50
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312A	2.95
316A	1.25
323B	4.95
327A	4.50
328A	3.95
336A	write
337A	6.00
349A	8.50
350A	4.50
368AS	4.00
383A	write
393A	4.90
394A	3.50
417A	8.50
434A	9.95
446A	1.19
446B	3.50
450TH	40.00
450TL	40.00
WL456	59.50
464A	3.50
WL530	16.95
CK536AX	.95
GL562	write
GL605	write
WL616	99.50
GL623	150.00
KU627	17.50
KU628	write
WL-651	39.50
WL655/657	39.00
F660	write
F661	write
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701A	2.50
703A	2.25
705A	1.50
706AY	27.50
706BY	27.50
706CY	27.50
706DY	27.50
706FY	27.50
706GY	29.50
707B	13.55
708A	1.95
713A	.95
715A	3.00
715B	3.50
715C	13.00
717A	.90
719A	10.00
720BY	125.00
720CY	125.00
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721A	1.50
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723A	7.95
723A/B	12.00
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730A	20.00
803	2.75
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805	2.95
807	1.50
808	2.75
809	2.75
810	9.50
811A	3.50
812	2.95
813	7.95
815	2.50
826	8.50
829	6.00
829B	9.50
830B	1.50
832A	6.50
836	2.95
837	1.00
838	2.98
846	00.00
851	35.00
852	12.50
860	3.50
861	10.00
865	.98
866A	1.00
869B	35.00
872A	1.75
874	1.10
878	.95
880	300.00
884	1.00
889R-A	175.00
891R	125.00
GL893A	295.00
922	1.25
931A	3.75
935	5.00
955	.49
957	.49
958A	.69
959	1.50
CK1005	.69
CK1006	1.25
1616	.90
1619	.30
1625	.30
1629	.30
1630	.89
1636	1.25
2050	1.00
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ZB3200	8.00
5128/FG67	15.00
5516	5.50
5586	200.00
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5611	115.00
5633	8.95
5634	8.95
5636	5.25
5637	4.00
5639	8.95
5643	6.95
5646	8.95
5651	2.50
5654	1.75
5656	14.95
5657	150.00
5670	3.50
5672	1.29
5676	1.29
CK5678	1.00
5687	3.75
5693	4.25
5694	2.60
5702	2.95
5704	2.50
5718	6.00
5719	8.95
RK5721	189.50
5750	3.10
5787	6.00
CK5787	4.95
5814	1.75
5844	4.50
5902	8.95
5904	8.95
5905	8.95
5907	9.00
5908	9.00
5916	9.00
5932/6L6WGA	4.95
5972	4.50
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6026	2.25
6110	8.95
6111	9.50
6121	9.95
6201	4.50
8005	4.95
8012	1.95
8013	4.95
8020	1.25
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9002	.98
9003	1.30
9004	.49
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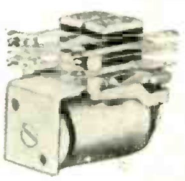

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OA3	.85
OB2	.85
OB3	.85
OC3	.85
OD3	.85
1B24	6.75
1B29	2.40
1B32/532	1.00
1N21B	1.65
1N23B	2.40
1N26	7.75
1N34	.64
1N43	1.35
1N81	1.35
1P23	2.50
1P36	3.95
1P40	1.50
2C39	12.50
2C39A	15.00
2C40	7.75
2C42	7.50
2C43	14.50
2C46	7.50
2C52	3.50
2D21	.75
2J33	20.00
2J34	17.75
2J39	12.50
2J54	47.50
2J62	17.50
2K22	17.50
2K23	15.50
2K28	25.00
2K33A	65.00
2K54	65.00
2K55	65.00
2X2/879	.45

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3A5	.79
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3B26	2.75
3B28	3.75
3C24	1.00
3C33	8.75
3E29	11.50
4C22/HF100	10.50
4D22	17.50
4E27	13.50
4J52	150.00
5R4GY	1.45
C6J	6.50
6AS6	1.75
6C21	18.00
10Y	.45
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28D7	.95
FG32	8.95
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QK60	60.50
QK61	60.50
FG98	17.50
FG105	25.00
F123A	6.95

F127A	17.50
HF200	13.50
204A	37.50
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RX233A	3.25
250TH	19.00
304TL	6.95
307A	2.25
313C	2.85
316A	.85
394A	2.50
GL434A	10.75
446A	1.00
450TH	44.00
506AX	1.10
507AX	1.00
702A	1.75
703A	2.50
704A	.85
705A	1.50
707A	4.95
715A	2.95
715C	15.85
717A	.85
723A	9.95
801A	.35
807	1.45
813	8.50
814	2.50
815	4.25
816	1.40
829	6.65
829B	9.95
832	7.25
832A	7.50

837	.95
845	12.50
860	1.75
865	.95
866A	1.25
872A GE	2.75
878	1.25
918	2.00
919	2.00
921	1.40
923	1.75
931A	3.95
954	.25
955	.35
956	.35
957	.35
CK1005	.45
CK1006	1.95
1608	.95
2050	1.20
2051 RCA	.85
5591 WE	5.75
5635	9.75
5636	5.75
5642	1.00
5651	1.95
5654	1.65
5670	3.25
5676	1.15
5725	4.10
5726	1.50
5749	1.90
6080	3.50
6097	1.50
7193	.45

8012A	1.95
8013A	3.50
8025	4.58
9001	.85
9002	.80
9003	1.25
9004	.25
9005	1.95
9006	.25
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3AP1	4.95
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3DP1	2.75
3GP1	2.75
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5BP1A	8.00
5HP1	4.25
5HP4	4.25
7BP7	4.25
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1N21B	1.55
1N23A	2.25
1N23B	2.50
1N26	7.75
1N34	.64
1N43	1.50
1N81	1.35

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1A7GT	.60
1C5GT	.45
1E7G	.85
1L4	.45
1Q5GT	.60
1S5	.60
1T4	.55
3B7	.33
3D6	.33
3Q4	.60
3S4	.60
5T4	.99
6A8	.65
6AC7	.75
6AG7	.95
6AK5	.75
6AL5	.49
6H6	.40
6J6	.65
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1.5-30mc automatic direction finder. This equipment used to take bearings on transmitters within its freq. range. Complete equipments available comprising the following: BC-1147A Rec., PN 31, Power Panel, BC-1159, automatic bearing goniometer. RC-223 antennae system consisting of 5 masts with legs, MC-412, MC-413 phase inverters calibrating transmitter, cables, 115v 60 cyc gasoline generator. Complete equipment overhauled and guaranteed. .... POR

VE REMOTE PPI INDICATOR

This is a remote PPI indicator "7 in." screen for use with any Radar for remote viewing. Contains all indicating circuits and is driven by the main Radar. Input 115v 60 cyc. POR

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This equipment is used for navigation, surveying, and automatic blind bombing. Operates in conjunction with AN/CPN-2 ground-beacons. Operating frequency of this equipment is 290mc. The accuracy is plus or minus 10 feet up to its range of 300 miles. We can supply bombing computers, if desired we can supply APN-3 spares. AN-CPN-2 ground-beacons also available. .... POR

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This is a very compact unit designed to be attached to either a radio or telephone circuit to scramble speech or code. This equipment utilizes coded cards in each terminal equipment. Unless the properly numbered card is inserted on the receiving end the speech can not be unscrambled. This provides an excellent privacy system. Complete equipment available consisting of: scrambler, code card set, cables, etc. This equipment can be used with any field or airborne communications equipment. Input 28v D.C. Mfg. Western Electric .... POR

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SCR-206

Portable direction finder. Frequency 200kc-18mc. complete sets available consisting of BC-470 receiver, LP-22 loop, sense antennae, power supply, operates from 6v DC. Mounted in a transporting trunk.

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Back Pack and mobile Walkie Talkie. Operating range 40-48mc 41 channels. Frequency modulated. This equipment is the standard walkie-talkie used by many armed forces throughout the world. Complete sets available consisting of: trans.-rec., battery box, handset antennaes. We can supply these sets to operate from a dry battery or with a 6, 12, or 24v DC vibrapack for vehicular use... POR Spare parts in stock. Also RC-291 ground plane antennae systems for greatly extended range. .... POR

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This equipment is inclosed in a 6 ft high rack cabinet with doors. Single voice channel operation for point to point communication. The rec.-trans. is tuneable. Wave guide is used in the trans.-rec. circuits. Mfg. SPERRY Input 110v 60cyc.

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6D4	2.70
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6S4	.66
6SA7	.48
6SG7	.59
6SH7	.58
6SK7	.58
6SL7	.58
6SN7	.81
6SR7	.53
6SQ7	.51
6U4	.39
6Y6	.92
6W4	.61
6X4	.49
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7A7	.69
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7B7	.69
7C4	.28
7C5	.96
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12SR7	.56
12SF5	.44
12SG7	.69
12SH7	.62
12SJ7	.46
12SK7	.51
12SN7	.74
12SL7	.66
14A7	.63
14B6	.64
14B8	.66
14N7	.76
14R7	.69
14W7	.69
25L6	.69
25Z6	.56
28D7	1.49
35L6	.76
35Z5	.51
35Y4	.49
50A5	.72
50B5	.69
50C5	.79
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77	.59
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1N43	1.70
1N45	1.40
1N46	.65
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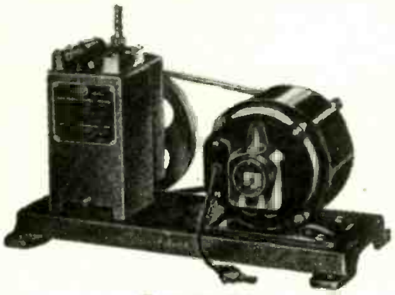

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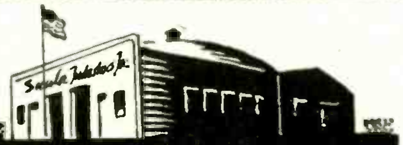

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.5	150(L)	5.34	60	25	1.30	500	150(L)	6.98
1	50(J)	2.34	75	25(H)	1.86	500	150	4.20
1	50	1.64	75	25	1.30	500	300(N)	8.42
1.1	50	1.64	75	50	1.47	585	150(L)	5.05
2	25(H)	1.86	75	75(G)	3.15	750	25(H)	1.86
2½	100(K)	3.79	75	300	6.30	750	150	4.20
3	100(K)	3.79	80	50(J)	2.10	780	100(K)	3.55
3	225(P)	6.99	80	500(R)	12.18	800	25	1.30
5	25	1.30	100	25(H)	1.86	1000	25(H)	2.10
5	50(J)	2.10	100	25	1.30	1000	25	1.47
5	100(K)	3.79	100	50	1.47	1000	50(J)	2.22
6	25(H)	1.86	100	100(K)	3.55	1200	225(P)	6.99
6	50(J)	2.10	100	150(L)	5.05	1200	300	6.30
6	75(G)	3.15	125	25(H)	1.86	1250	50(J)	2.22
7	25	1.30	125	25	1.30	1250	150(L)	5.34
7.5	75(G)	3.15	150	50(J)	2.10	1500	25(H)	2.10
7.5	225(P)	6.99	175	25(H)	1.86	1500	25	1.47
8	50(J)	2.10	175	500(R)	12.18	1500	50(J)	2.22
8	50	1.47	185	25	1.30	1600	50(J)	2.22
8	500(R)	12.18	200	25(H)	1.86	1800	50(J)	2.22
10	25(H)	1.86	200	25	1.30	1800	150(L)	5.62
10	50	1.47	200	50	1.47	2000	25(H)	2.10
10	100	2.97	200	100(K)	3.55	2000	50	1.55
12	25(H)	1.86	200	150(L)	5.05	2250	150(L)	5.62
12	50	1.47	250	25(H)	1.86	2500	25	1.47
12.5	500(R)	12.18	250	50	1.47	2500	50(J)	2.22
13	100(K)	3.55	300	50(J)	2.10	2500	100(K)	3.71
15	25(H)	1.86	300	50	1.47	2500	150(L)	5.62
15	25	1.30	300	75(G)	3.15	3000	25	1.47
15	75(G)	3.15	300	100(K)	3.55	3000	100(K)	3.79
15	100	2.97	350	25(H)	1.86	5000	25(H)	2.22
16	50	1.47	350	25	1.30	5000	50(J)	2.34
20	25(H)	1.86	350	150(L)	5.05	5000	100(K)	4.04
20	50(J)	2.10	370	25	1.30	7500	50(J)	2.34
25	25(H)	1.86	378	150(L)	5.05	7500	100(K)	4.30
30	50	1.47	400	25	1.30	10K	50(J)	2.50
37.5	50	1.47	400	75(G)	3.15	10K	50	1.75
40	225(P)	6.99	500	25(H)	1.86	10K	100(K)	4.54
			500	25	1.30	15K	25	1.93
50	25	1.30	500	50	1.47	20K	4	.75
50	50(J)	2.10	500	75(G)	3.15	20K	150(L)	6.98

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.00015	5 KV	12.18	.001	6 KV	14.00
.00015	6 KV	12.18	.0015	6 KV	14.67
.0002	6 KV	12.18	.02	3 KV	15.44
.00024	6 KV	12.76	.032	2 KV	15.44
.00025	6 KV	12.76	.04	1 KV	17.55
.0004	6 KV	13.31	.051	1.5 KV	18.21
.0005	6 KV	14.00	.08	1.5 KV	19.72
.00075	6 KV	14.00	.09	1.5 KV	20.25

G-2 TYPE

.0001	10 KV	19.67	.0005	10 KV	19.67
.00015	10 KV	19.67	.00065	10 KV	19.67
.0002	10 KV	19.67	.0008	10 KV	19.67
.00027	12 KV	19.67	.001	10 KV	19.67
.0003	10 KV	19.67	.01	5 KV	20.75
.000375	10 KV	19.67	.03	2 KV	21.00
.0004	5 KV	19.67	.045	2 KV	21.00

G-3 TYPE

.00005	20 KV	33.27	.0011	20 KV	43.50
.0001	20 KV	36.30	.0012	20 KV	44.62
.0001	25 KV	37.80	.00124	15 KV	44.75
.00015	20 KV	37.80	.0015	20 KV	45.38
.00025	20 KV	39.33	.0016	15 KV	42.96
.0003	20 KV	39.33	.002	12 KV	42.35
.0004	20 KV	41.15	.0025	12 KV	45.00
.00045	15 KV	41.15	.004	12 KV	45.38
.00047	20 KV	41.15	.005	5.5 KV	28.50
.0005	20 KV	41.15	.006	10 KV	45.38
.0008	20 KV	41.15	.015	3 KV	45.38
.00095	5 KV	42.35	.015	7 KV	45.33
.001	15 KV	42.35	.05	3 KV	45.81
.001	20 KV	42.35	.25	1.6 KV	45.81

G-4 TYPE

.00025	30 KV	66.35	.0025	25 KV	68.73
.0003	25 KV	66.35	.005	20 KV	75.68
.00032	25 KV	66.35	.006	15 KV	75.68
.00032	30 KV	66.35	.0066	15 KV	75.68
.0005	30 KV	66.35	.0075	15 KV	78.00
.0006	35 KV	67.50	.01	15 KV	81.73
.00062	30 KV	66.35	.01083	12 KV	81.73
.00065	35 KV	67.50	.01163	5 KV	30.60
.0008	30 KV	66.35	.03	8 KV	81.73
.001	25 KV	68.73	.056	5 KV	83.17
.0015	25 KV	68.73	.05668	2 KV	30.75

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20	solid	.81	7.20	6.50/M
22	stranded	.81	7.20	6.50/M
22	solid	.75	6.75	6.25/M
24	stranded	.75	6.75	6.25/M
24	solid	.72	6.50	6.00/M
26	stranded	.72	6.50	6.00/M
26	solid	.65	6.00	5.50/M
Twisted Pair #22: 2 color			1.50/C	12.00/M

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90° C—600V Rating

AWG		100 ft	1000 ft	over 1000 ft
18	stranded	1.10	10.00	9.00/M
18	solid	1.00	9.00	8.10/M
20	stranded	1.00	9.00	8.10/M
20	solid	.90	8.10	7.20/M
22	stranded	.90	8.10	7.20/M
22	solid	.81	7.20	6.50/M
24	stranded	.81	7.20	6.50/M
24	solid	.75	6.75	6.25/M
26	stranded	.75	6.75	6.25/M
26	solid	.72	6.50	6.00/M

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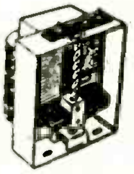

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JULY, 1954

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OA2	$1.00	1N23C	7.50	2J40	29.00	3B28	8.00	4J34	109.00	7BP7	5.00	242C	10.00	MX408U	.50	715C	22.50	810	10.50	884	1.50	Various 5000 and 6000 series of new production	
OA3	1.10	1N25	4.50	2J42	135.00	EL3C	5.50	4J35	150.00	7DP4	9.00	244A	9.50	417A	15.00	717A	1.50	811A	3.75	885	1.50		
OB2	.99	1N26	6.75	2J49	60.00	3C22	99.00	4J36	150.00	12AP4	50.00	249C	4.25	434A	15.00	718AY/		812A	3.95	914A	75.00		
OB3	1.10	1N27	3.50	2J50	55.00	3C24	1.50	4J37	150.00	12DP7	24.00	250TH	19.95	446A	1.95	EY	30.00	813	13.75	931A	5.00		
OC3	.96	1N34A	.79	2J55	150.00	3C31	2.95	4J38	150.00	LM15	225.00	205TL	12.00	446B	3.95	719A	22.50	814	3.75	954	.35		
OD3	.89	1N43	2.25	2J56	110.00	3DP1	7.50	4J39	150.00	15E	1.75	274B	2.75	450TL	45.00	720AY/		815	6.25	955	.50	8012	2.00
C1B	2.95	1P25	75.00	2J61	35.00	3DP1A	10.00	4J40	150.00	15R	.75	304TH	10.00	450TH	52.50	GY	150.00	816	1.45	956	.75	8012A	2.50
1B21	1.50	2B4	1.25	2J62	35.00	3DP1A-		4J41	150.00	NE16	.59	304TL	10.00	464A	7.50	721A	3.50	829	11.00	957	.25	8013	3.00
1B22	1.50	2B22	1.75	2K22	15.00	52	10.00	4J42	190.00	20-4	.75	307A	3.50	471A	1.25	722A	3.50	829A	12.00	958A	.60	8013A	3.50
1B23	6.95	2C34	.15	2K23	15.00	3EP1	5.00	4J51	190.00	KY21A	8.25	310A	4.50	527	18.00	723A/B	18.00	829B	15.00	959	2.25	8019	1.75
1B24	12.00	2C40	9.00	2K25	27.50	3E29	15.50	4J52	225.00	RX21	8.00	310B	4.95	WL530	23.00	724A	1.95	830B	2.00	E114A	.25	8020	1.80
1B26	1.75	2C42	12.00	2K26	68.00	3FP7	5.00	4J53	225.00	HK24G	1.50	311A	6.50	WL531	22.50	724B	2.25	832A	9.95	1280	.95	8025	3.75
1B27	12.50	2C43	14.50	2K28	35.00	3HP7	5.00	C5B	250.00	25T	2.95	312A	3.50	WL532	1.75	725A	9.00	833A	45.00	1500T	135.00	PD8365	96.00
1B32	2.95	2C44	.60	2K29	35.00	3GP1	5.00	5BP1	3.95	45 Special	.35	323A	15.00	WL533	15.00	726A	18.00	834	7.50	HK1554	75.00	9001	1.25
1B38	35.00	2C46	7.50	2K33A	75.00	4B26	5.40	5BP2A	12.00	RK39	2.75	327A	3.75	HK654	35.00	726B	45.00	836	3.95	1603	5.00	9002	.90
1B50	23.00	2E22	2.25	2K39	140.00	4C27	22.50	5BP4	3.95	HF50	1.75	328A	6.75	700A/D	10.00	726C	45.00	837	2.75	1612	1.50	9003	1.25
1B51	7.50	2J21A	12.00	2K41	135.00	4C28	35.00	5CP1	7.50	VT52	.35	350A	10.00	701A	4.50	728AY/		838	5.95	1613	1.25	9004	.35
1B56	35.00	2J22	9.00	2K45	80.00	4E27	16.00	5CP7	6.95	HK54	4.50	350B	5.95	703A	3.95	GY	15.00	849	35.00	1616	1.25	9005	2.75
1B60	35.00	2J26	15.00	2K50	275.00	4J25	150.00	5CP7A	14.00	RK72	1.00	352A	3.00	704A	1.95	730A	22.50	860	3.50	1619	.45	9006	.25
1N21	1.25	2J27	15.00	2K54	125.00	4J26	150.00	5D21	18.00	RK73	1.00	HK354C	15.00	705A	21.75	750TL	99.00	861	25.00	1622	1.50		
1N21A	1.75	2J31	24.00	2K55	125.00	4J27	150.00	5FP7	1.95	FG95	19.95	357A	15.00	706AY/		801A	.90	866A	1.50	1624	1.75		
1N21B	2.75	2J32	29.00	2K56	72.00	4J28	150.00	5JP1	27.50	100TH	7.95	368AS	4.95	FY	5.00	802	3.95	869B	67.50	1625	.35	Thousands of other tubes	
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1N22	1.00	2J34	36.00	3BP1	7.20	4J30	150.00	5JP4	27.50	122A	1.75	385A	4.50	707B	15.00	805	4.95	872A	3.50	1851	1.80		
1N23	1.95	2J36	90.00	3B24	4.50	5J31	150.00	5J23	45.00	203A	7.50	388A	1.80	714AY	18.00	807	1.50	878	1.50	2000T	150.00		
1N23A	2.75	2J38	8.95	3B25	5.50	4J32	150.00	C6A	11.00	211	.95	393A	7.50	715A	4.50	808	1.95	879	.50	2050	1.80		
1N23B	2.75	2J39	8.95	3B26	5.00	4J33	150.00	C6J	7.50	217C	12.00	394A	3.95	715B	9.00	809	2.95	880	250.00	2051	1.00		

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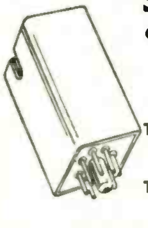

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A	.02	600	69c; 5 for	2.25
A	.015	2500	1.75: 2 for	3.00
B	.01	600	56c: 3 for	1.20
B	.01	1200	69c: 3 for	1.49
A	.005	2500	1.19; 3 for	2.95
B	.004	600	49c: 3 for	1.10
B	.002	1200	58c: 3 for	1.25
A	.002	2500	98c: 3 for	2.25
A	.001	1200	55c: 3 for	1.20
C	.0007	3000	89c: 3 for	2.39
A	.0004	2500	39c: 6 for	1.95
A	.0001	600	25c: 5 for	1.00
C	.0001	3000	89c; 3 for	2.00
C	.0001	5000	1.49; 4 for	5.00

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2J34	24.98	6AV6	.49	12BH7	1.29	705A	1.88	5812	2.99
2J37	12.70	6B4G	1.18	12SA7GT	.68	707A	7.90	5814	2.08
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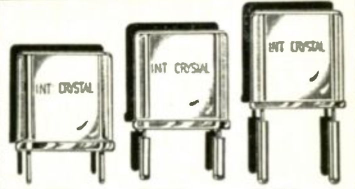

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(3) Circuit Data (32 mmf load, series resonance, etc.)
(4) End Use (Equipment type & manufacturer, development, etc.)

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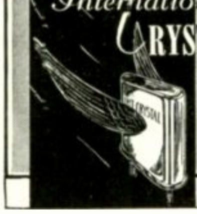

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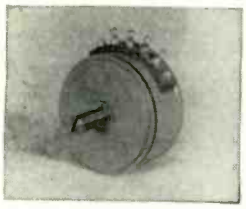
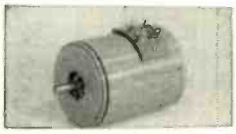
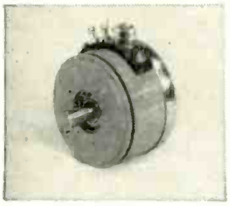
Rattray precision potentiometers have a wide scope and cover many types and sizes, in the field of wire-wound units of high accuracy, long life and stability. Rattray's designs are compact, having mechanical and electrical capabilities of the highest quality. The two basic lines include: single and multiple turn linear and non-linear models. Rattray has the facilities for quantity production orders; fast deliveries made on sample and special requirement quantities.







GENERAL SPECIFICATIONS

Models	106	162	200	300	181-3	181-10
Dimensions:						
Diameter, in.	1.060	1.620	1.985	2.985	1.820	1.820
Length, single unit, in.	0.656	0.838	0.838	0.838	1.200	2.080
Add per section, in.	0.500	0.615	0.615	0.615	0.880	1.560
Resistance Range, ohms:						
Linear, max.	50,000	140,000	178,000	283,000	100,000	350,000
Non-linear	A	A	A	A	A	A
ElectricalContact Angle	350°	350°	350°	350°	1080°	3600°
Functional Tolerances:						
Linear	±0.35%	±0.15%	±0.10%	±0.075%	±0.1%	±0.075%
Non-linear	to ±0.5%	±0.5%	±0.4%	±0.3%	±0.5%	±0.3%
Torque Per Section, oz. in.	0.5	0.5	0.5	0.5	1.0	1.0
Wattage Rating at 40°C	1	2.5	4.0	5.0	3	5
Operating Temperature Range	B	B	B	B	B	B
Resolution, Max.	1/1500	1/2500	1/3300	1/5300	1/6000	1/20,000

Function tolerances indicated are typical and vary with resolution.
In all cases, extra taps can be provided as required.
Ball bearings available if required, and will increase length slightly.
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B. − 55°C to + 75°C standard.

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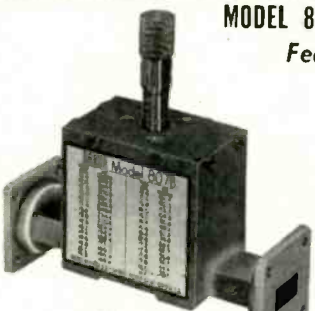

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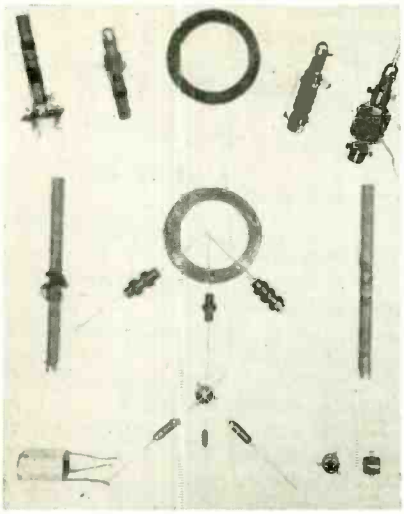

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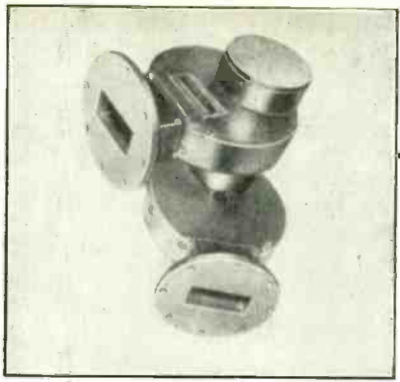

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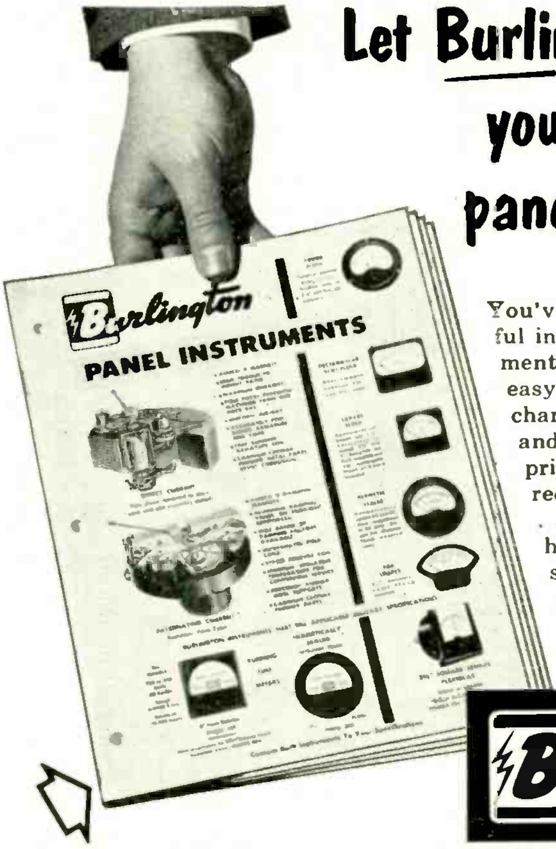

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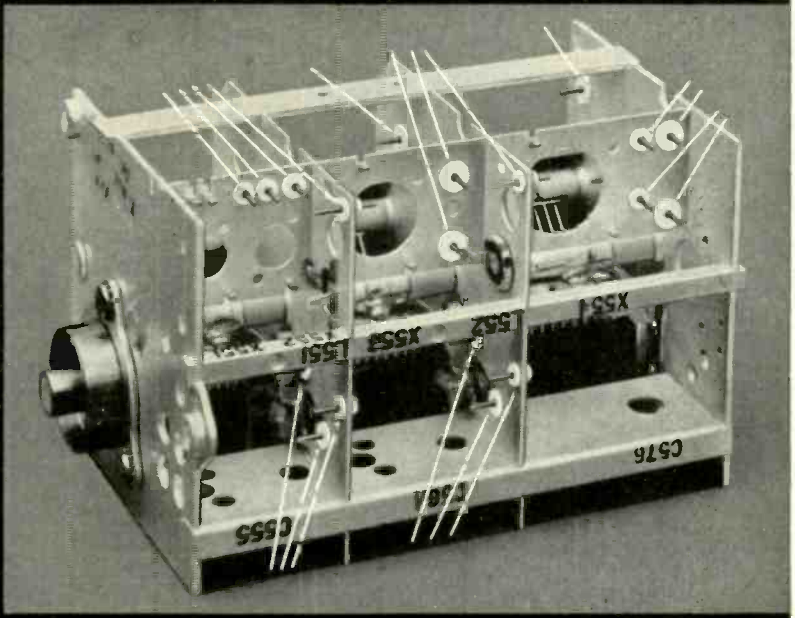

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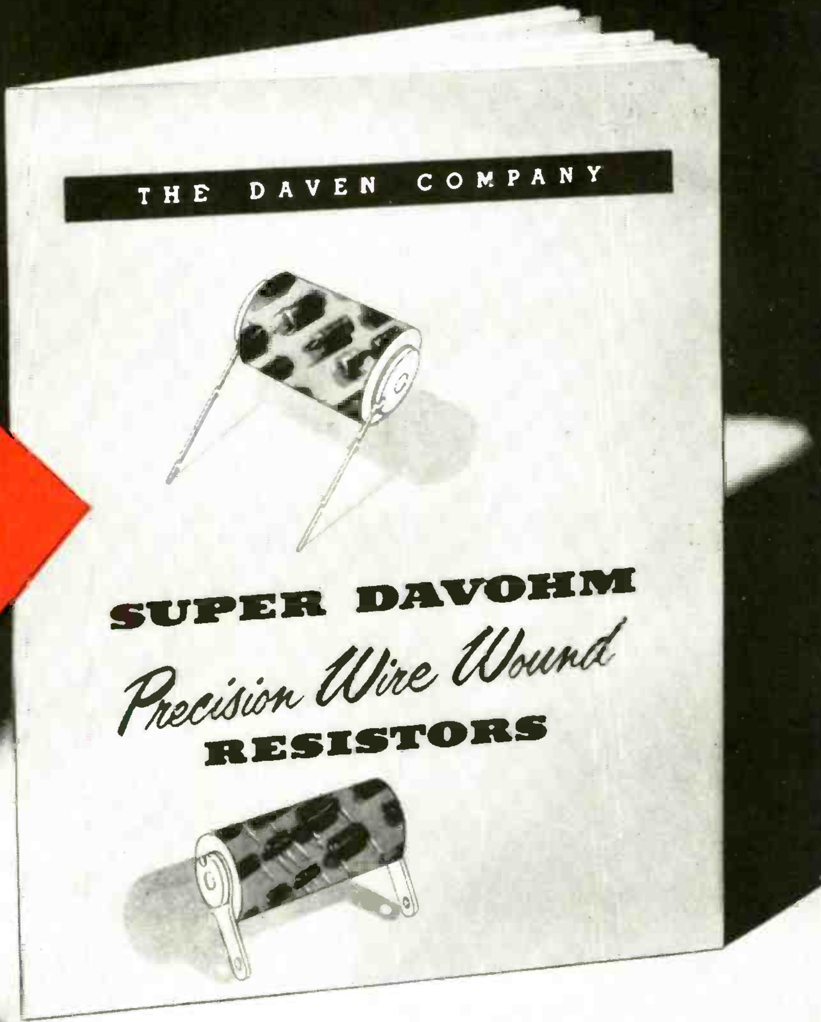

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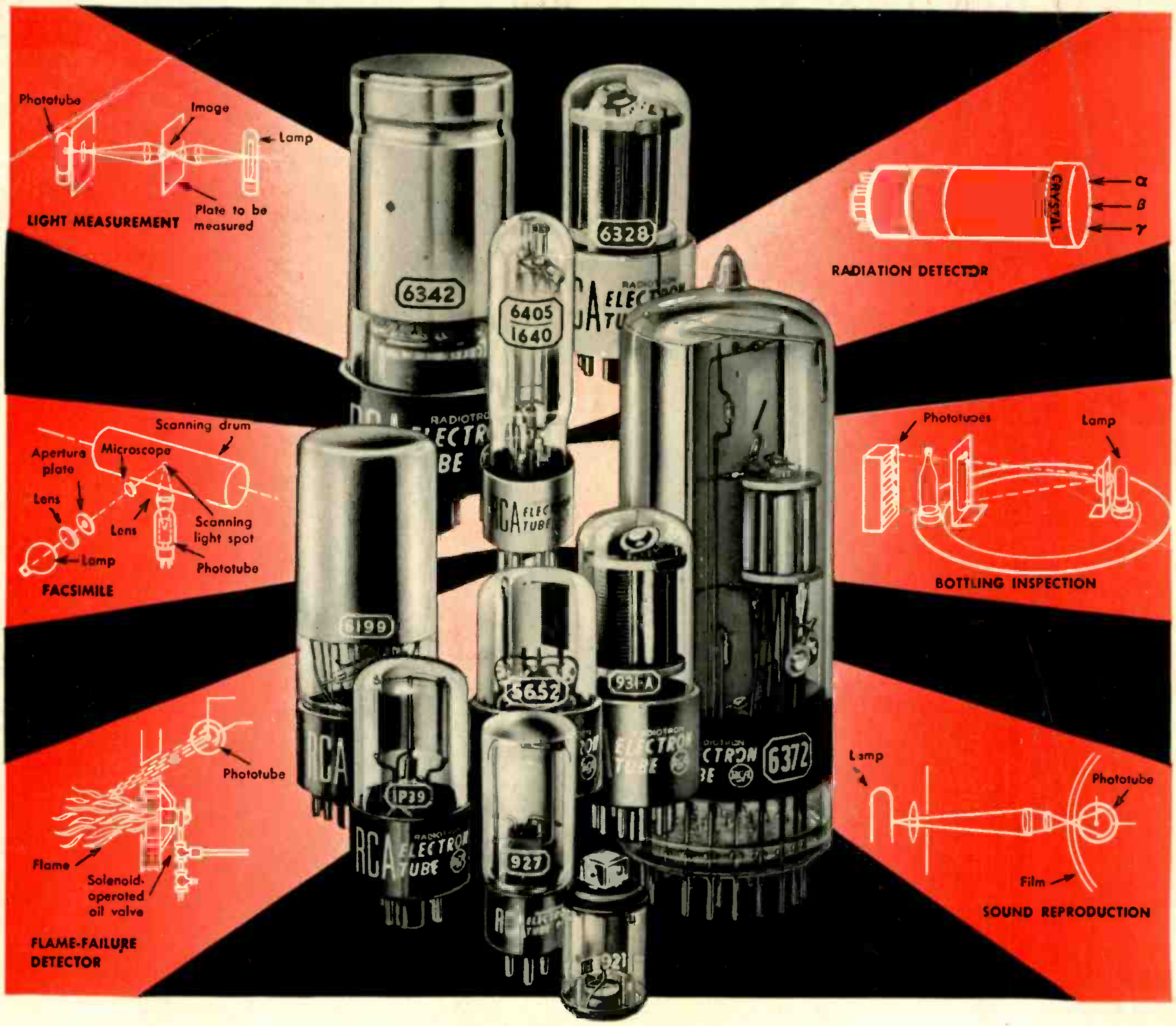
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